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Theory and Practice in Engineering

III—Steam Heating

By KONRAD MEIER.

(This series of articles commenced in the June, 1913, issue.)

While the general use of hot water heating for many purposes to which it is best adapted, has been retarded through lack of understanding, the development of steam heating has also suffered from the same cause, in various ways. It is true that defective steam circulation can be overcome more easily, but there are, nevertheless, some substantial reasons for the systematic design and calculation on a scientific basis.

The situation varies according to the nature of the case. With the ordinary, self-venting apparatus in which the pressure can be raised according to need and with sealed returns giving positive direction to the flow, the steam will reach all points eventually. But with unequal resistances to the points of delivery there will be a difference in the time required to fill and warm up the less favored radiators at the end of the line, which are generally in the most exposed rooms, always coldest in the morning. When, in addition, the steam generation is scant, it is likely that most or all of the supply is condensed in the nearby rooms, instead of being induced to go where most needed, which is the idea of proper distribution. At best, some of the rooms are liable to overheating and the benefits of whatever general regulation that might be possible with steam heat, are not obtained. Also, a higher working pressure becomes necessary, which is certainly not conducive to economy. With the pipe system calculated as it should be, no branch is favored and each radiator will receive its share of the steam production from the lowest possible pressure and upwards. This will allow better utilization and at least some variation of the heat to suit the weather.

The difficulties due to lack of equalization will increase with the apparatus having dry returns. As shown in the introduction to this article, the steam, under such conditions, is most liable to back up against the condensation, obstructing drainage, causing noise and retarding the removal of the air when entering radiators from both ends.

POINTS TO CONSIDER IN CALCULATING A DRY RETURN SYSTEM.

A dry return system, as illustrated in Fig. 4, should be calculated so that, for instance, the branch at b can pass only steam enough to fill its own radiator, plus the return branch and the run of the return main from b to m. If made of equal size as the branch at f the steam would rush first through b-l, because of least resistance, and reach k, i and possibly g before it can fill the other radiation.

The relief d-k, should be sized so that it can pass only steam enough to fill the run k-l. For some cases, however, it is difficult even to approximate this capacity. Hence a sealed relief would be appropriate. The same might be done at e-h, unless the pipe can be made sufficiently small and long to prevent an excessive rush of steam toward g. If both d-k and e-h are sealed, the condensation in the return mains from l to g will have to be made up by the steam passing through branch and radiator at f and running down and toward the boiler from point g.

This is the proper way but it is plain that the volume of steam for that branch would be materially increased. Furthermore, the run b-c-d-e-f-g-h-i-k-l is much longer than b-l direct through the radiator. The pressure drop either way should be the same. It is necessary, therefore, to make the near branch smaller, increasing its resistance per lineal foot and, at the same time, to ease the flow of steam towards the far end by keeping down the velocities.

If a pipe system is perfectly proportioned on this principle, that is, for an equal pressure drop from the boiler to all points of delivery, which latter must include the steam condensed within the returns, it will circulate smoothly and noiselessly, even while heating up. Radiators will vent under equal pressure and rooms will warm up at the same time.

Large Mains Are Necessary.

This method of calculation will, at least for long runs, result in larger mains than those figured from empirical tables. But this is necessary for successful operation. It will keep down the total pressure loss and prevent the water from backing up from the boiler, which is due generally to an excessive difference between the steam space in the boiler and the return end, as expressed by the water column H in Fig. 4. No check valves are necessary on return mains, when this height, which represents the total pressure loss through the movement of steam, is kept low enough, so that the water can never reach and flow over into the horizontal mains. Of course, allowance must be made for increased pressure loss while heating up. Nor will equalizing pipes at boilers help in this respect. They merely increase the water contents. Sometimes they are supposed to drain the steam mains, which ought to be large enough in any event to prevent water from being drawn up into them. The idea must be to transmit the boiler pressure to the far end of the system as much as possible.

Keeping down the water line in the return by ample mains and low resistances will make it perfectly safe, where necessary, to keep radiation closer to the level in the boiler than is generally considered good practice. The safety lies in knowing the factors in a given case.

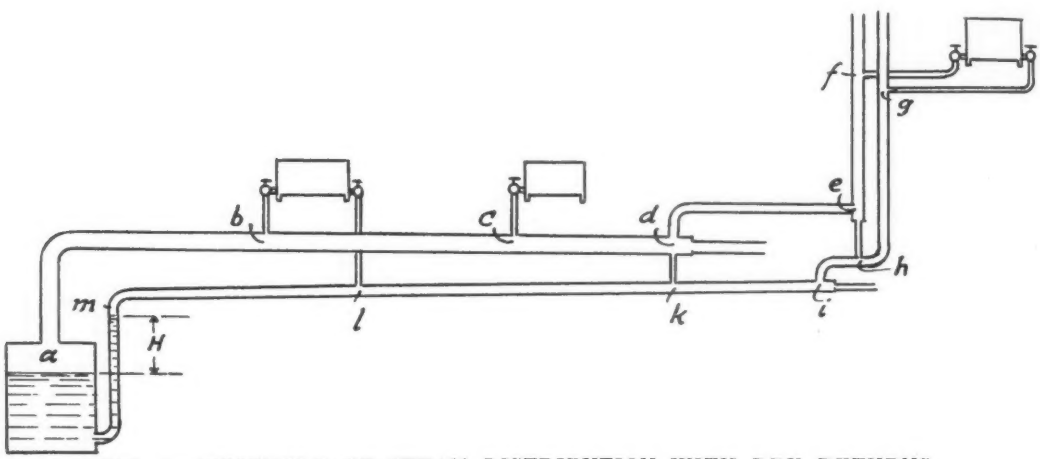

FIG. 4.—SCHEDULE OF STEAM DISTRIBUTION WITH DRY RETURNS.

Sometimes water will be entrained by priming. Whatever the cause may be, the calculation will help to establish it and will at least prevent those numerous difficulties which are due to improper distribution of pressure.

Vacuum Most Desirable Within the Steam Lines.

When exhaust from steam motors is used for heating, the working pressure must be kept close to the atmospheric. A vacuum would be most desirable in many cases, but for various reasons it is rarely maintained, within the steam lines, where it would benefit the power plant. It is generally applied only to the air lines or returns, with the main purpose of accelerating the removal of air and sometimes for curing defects in the circulation of steam and water.

Considering that any low pressure steam heating apparatus, even of large dimensions, with wet or dry returns, can be made to circulate perfectly at less than 1-10 lb. per square inch, excess or back pressure, and will get rid of the air at little if any more, if the pipe system is well-designed and proportioned, it seems proper to consider whether, in a given case, a vacuum system will pay for itself or not. It may be claimed, that the vacuum allows the use of smaller piping. Whether this would be good practice seems debatable in view of the fact that smaller steam piping inevitably increases the pressure losses and, therefore, also the back pressure, since the suction applied to automatically closing return and air valves cannot help the circulation after they are shut. When these valves are perforated to allow continuous leakage, the volume of steam to be handled will increase materially and with it the pressure drop, as the square of the velocity. Any of the suction that will penetrate the perforations is most liable to be neutralized by the greater pressure difference required to move the steam.

It does not seem rational to crate several inches (mercury) of vacuum, especially when extra power must be expended, in order to pull steam and air through a series of pinholes and small return piping, when the desired result can be obtained by simple and natural means with a very small fraction of the pressure drop, which can put no material handicap on the power plant. Some initial cost might be saved by small return lines, but this would probably be more than offset by more expensive automatic valves or traps and other apparatus. The maintenance should also speak in favor of the simpler equipment.

Taken altogether, it would seem that the cost of equipping an apparatus with vacuum devices can, at least in many new plants, be saved by appropriate design, developed from a study of pressure conditions and based on scientific calculation of the pipe system, which does assure a smooth working and easily venting apparatus at a working pressure that would be acceptable almost anywhere.

Even when vacuum is to be applied for one reason or another, the methodical way of sizing the pipes, with a view to equalization, will amply repay the extra pains by a more responsive plant. The nature of the problem must be understood, of course, and some practice obtained in applying the data, which is also obtainable in charted form, before the best results can be expected.

Advantages of Large Pressure Drops in Long Runs.

High pressure steam is used sometimes to carry heat for long distances. In such cases, a large drop of pressure between points where steam is generated and used is permissible and advantageous, as a rule. Larger pressure drop results in smaller piping, smaller heat losses and less or no condensation. Systematic calculation will show the possibilities in this respect and determine the best proportions in a given case. It will also give the heat developed by friction and its effect on the condition of the steam delivered. The study of pressure distribution again will lead to the proper disposition of reliefs, traps, etc., and assures a smoothly-working system.

Taking on the whole, it is often found practicable to get along with smaller piping and less apparatus, if the result can be foretold. The margin of safety in thumb rules is eliminated. Hence the scientific way is conducive to economy.

(To be continued.)

Experiments in School Room Ventilation with Reduced Air Supply Through Individual Ducts*

By Frederic Bass.

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It is a well-known fact among ventilating engineers to-day that the practice of ventilating has, in most cases, little, if any, scientific physiological basis. The mechanical principles governing the selection and types of fans, the relations of pressure and velocity of flow of air in pipes of various sizes, the transference of heat and other purely mechanical and engineering factors are quite well appreciated and applied. But the fact that the physiological factors are fundamental and primary and that the mechanical principles are secondary seems for many years to have escaped general recognition, and it is only in very recent years that engineers have come to realize that a knowledge of applied mechanics is but a small part of the problem of ventilation and that physiological and psychological demands are of prime importance.

During the past few decades engineers have been designing apparatus to deliver into the rooms to be ventilated a certain fixed quantity of air, the object being to keep the carbon dioxide content down to a prescribed minimum, usually from 8 to 14 parts per 10,000. It has been known that carbon dioxide itself is not harmful in quantities ordinarily found and that its effects on the human organism are not noticeable until it rises to perhaps 300 parts per 10,000, a figure never approached in practice. But the carbon dioxide has been used as an indicator of so-called "impurities" in the air. Laboratory experiments by many investigators have failed to demonstrate these impurities in chemical terms, but the human nose has conveyed the impression to the human brain that something was wrong when the carbon dioxide in an unventilated, occupied room rose above the figures mentioned. Other sensory nerves have corroborated the impression.

In the laboratory experiments just alluded to it has been amply demonstrated that a human being may suffer severely from stagnant air, especially when its temperature and humidity were high, while with air in motion and of moderate temperature and humidity, although with carbon dioxide over 200 parts per 10,000 and oxygen below 19 per cent., no discomfort or adverse physiological results appeared. If these laboratory experiments were corroborated under ordinary working conditions it would be at once evident that the standard ventilating practice of the present is unsound and probably inefficient, since so little attention is given to the conditioning of the air and its control in the occupied space, while over-emphasis is placed on mere quantity.

In the experiments described in the following it was attempted to so arrange the ventilation that the quality of the air of the room with respect to humidity, temperature and odors would be under control and, further, to so arrange the distribution of the air that each occupant would be conscious of the moving air. The usual crowd odor was neutralized by means of ozone. It was impossible at times to operate the apparatus to its full efficiency on account of insufficient attendance; the humidity was variable throughout the experiments, whereas it would have been desirable to keep it constant, and there were a number of observations of interest, such as the carbon dioxide content of the room at various points, which might have been used if taken. Other shortcomings of the work are apparent, too, but the results are nevertheless interesting.

Air Recirculated in Tests.

The system was so operated during three weeks that the air delivered to the room was exhausted, not into the outside air, but into a duct leading to the fan delivering the air to the room; in other words, the air was rotated and used over and over again. Between the exhaust and delivery fans there was an ozone

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generator delivering approximately one part of ozone per 1,000,000 parts of air. The ozone generator was calibrated by the potassium iodide method by Mr. H. A. Whittaker of Minneapolis. A full description of the apparatus is as follows:

DESCRIPTION OF VENTILATING EQUIPMENT.

A room was selected on the first floor of the Jackson School in Minneapolis. The air to be delivered to the pupils in the room was taken in through a window in the basement and passed over two Vento radiators to a Warren Webster air washer and humidifier, thence to a heating coil, from which the air was blown to the outlets in the room by means of a Sirocco blower. These apparatus were loaned through the courtesy of Warren Webster & Co. and American Blower Co. The main duct from the blower was carried along the ceiling at one end of the basement room immediately below the room in which the pupils to be the subjects of the experiment were located and from it three ducts were extended parallel to the rows of desks. From these ducts the air was carried through 2-in. risers extending through the floor to each desk in the room above,

FIG. 1.—TYPE OF ORIFICE FIRST TRIED.

at which points it entered the room through funnel-shaped orifices.

Previous experiment with a single desk and funnel ventilator had shown that, with 7 cu. ft. of air per minute, the head and shoulders of the pupil could be surrounded by air moving at a velocity sufficient to carry away the breath but still not great enough to be objectionable. In this way it was made certain that each pupil would actually receive the air both in quantity and quality that was desirable, and, by means of a number of openings in the ceiling, through which the air was drawn by an exhaust fan, it was made equally certain that the exhaled air would be immediately removed from the room.

FIG. 2.—TYPE OF ORIFICE ADOPTED.

In the preliminary experiments to determine the best type and location of orifice for admission of air to the room, the first form experimented upon was an elongated orifice or slit in the front edge of the desk. Fig. 1 shows a view of this orifice. The funnel type, shown in Fig. 2, gave a much better distribution of air and for other reasons was much better adapted for use in a school room and it was accordingly adopted. Fig. 3 shows the school desks themselves with a number of these orifices in position. Fig. 4 is a view in the basement room below the room fitted out, and shows the heating coils, air washer, blower, regulating devices, as well as the system of pipes used to distribute the air to the desks. In addition to the inlets at the desks, two lines of 6-in. pipes with 1-in. x 2-in. rectangular orifices 1 ft. apart were placed along the two sides of

the room at a height of 6 ft. from the floor. Approximately 50 cu. ft. of air per minute was blown into the room through these openings.

The cumbersome appearance of the apparatus is due to the fact that the air washer, blower, and heating coils were loaned and were larger than necessary. The direct radiation in the room, the temperature of the entering air, and the temperature of the water in the air washer were automatically regulated by thermostatic control put in by the Johnson Service. The piping and sheet metal work was done by the Waterman-Waterbury Co. of Minneapolis.

In addition to the foregoing described

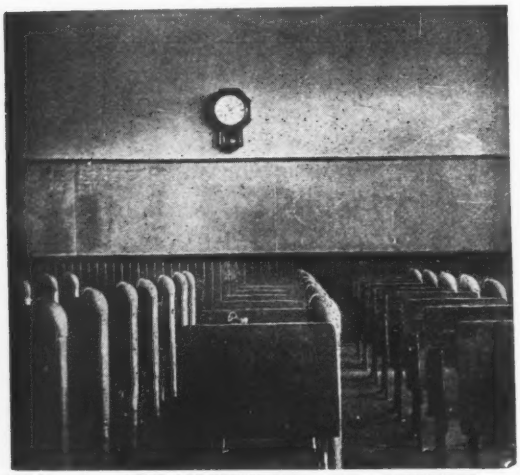


FIG. 3.—ARRANGEMENT OF SUPPLY DUCTS AND DESKS.

apparatus an ozone generator was installed by A. R. Willford, Minneapolis. The ozone was generated by an electrical current of 9,000 volts. It was forced into the pipe system by a small Sirocco fan. The ozone was introduced into the room in the proportion of one part to 1,000,000 parts of air. The heating of the building was performed by direct radiation controlled by Johnson thermostats.

Physiological and Psychological Tests.

A group of pupils in the room described was selected for physiological and psychological tests. A control group of children of the same grade and general characteristics of race and living conditions was selected in a nearby school, referred to hereinafter as the Adams School, where an ordinary fan ventilating system, delivering about 30 cu. ft. of air per pupil per minute, was installed.

The test was applied with about 8½ cu. ft. of renewed air per capita per minute. The control group had outside air. During the period the characteristic odor of ozone was perceptible in the test room and apparently kept the air in an acceptable and pleasant condition, for on one occason the motor-blower set which forced the ozone into the air current was temporarily disconnected and the teacher, not knowing what had happened, within half an hour felt it necessary to open the windows and to call attention to the marked change in the air.

The description of the experimental work may be divided into three diviisons as follows: (A) Physical records, including measurements of air velocities and volumes, temperature records and humidity observations; (B) Physiological observations, including bodily temperatures and blood pressures; and (C) Psychological tests, including division, substitution and motor tests. The manipulation of the plant was performed and recorded by Mr. W. J. Bingen, a post-graduate student in the College of Engineering; the physiological observations were made by Dr. E. J. Heunnekens, and the psychological work and computation were performed by Mr. H. D. Kitson, a post-graduate student in the College of Science, Literature and the Arts of the University of Minnesota.

Physical Records.

The performance of the fans and other apparatus had been determined previous to the beginning of these experiments by M. E. J. Lewis, a mechanical engineer of Minneapolis. The distributors on the desks were controlled by means of individual dampers, so that approximately 7 cu. ft. of air per minute was supplied through each. This rate was continued throughout the experiment as well as for two weeks before. The temperature was recorded by a Draper's self-recording thermometer and the humidity of the room was observed each day at 10 o'clock A. M. by the use of a Hygrodeik hygrometer which had been calibrated.

It was found that this instrument is easily accurate to 1%, provided the wick is kept clean. Both instruments were located on a shelf on an inside wall about 6 ft. from the floor.

The average temperature of the test room in the Jackson school was 68.8° F. and that the average relative humidity was 32.6% during the test. During the first week in which psychological observations were made the average temperature was 68.4° F., and during the latter week 68.8° F. The relative humidities were 35.6% and 29.8% respectively. The highest average daily temperature recorded was 71.9° F. and the lowest 65.1° F. The highest humidity observation was 50% and the lowest 25%.

the air did not greatly affect the humidity in this experiment.

PHYSIOLOGICAL OBSERVATIONS.

The physiological observation included observation of temperature and blood pressure during two weeks, one immediately preceding and the other during the last week, when the air of the test room was rotated. They were made on 10 children in the morning and 10 in the afternoon, the children being tested twice on the first test week and three times during the second test week.

Each child was tested at the same hour throughout the five tests, the morning measurements being made from 9:45 to 10:30 o'clock, the afternoon measure-

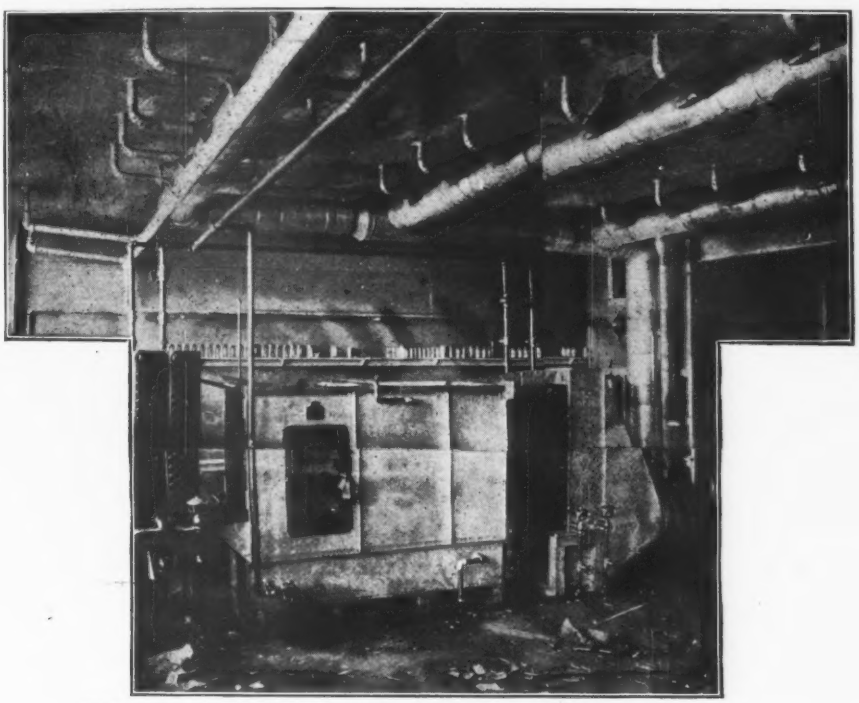


FIG. 4.—VIEW OF APPARATUS IN BASEMENT.

The temperature at the Adams school was kept approximately 68° F. No humidity records were kept, but, in all probability, these were not materially different from those in the Jackson school, since during the three weeks previous to the first test week the humidity in the Jackson school averaged 33.3% when outside air was supplied, as against 32.6% during the three weeks when the renewed air was supplied, which would seem to indicate that the revolving of

ments from 1:45 to .:30 o'clock. This brought them before recess and was done in order that the measurements might not be affected by the excitement resulting from play at recess. The average temperature of the average child for the first week was 98.67, m. v., 0.32; for the last week, 98.46, m. v., 0.28. The corresponding blood pressure measurements were 110.13, m. v. 5.47 and 106.25 m. v. 5.48.

The temperature tests showed no ap-

preciable difference. The blood pressure readings showed a difference, however, of 3.8 and is to be regarded as significant when considered in relation to the error of difference, which is 1.7. If these blood pressure tests may be regarded as a fair sample, the chances are only about four in 10,000 that this difference is not significant.

It is to be said, however, that the blood pressure tests have a low coefficient of correlation, that for the first and second days being 0.54, for the last two days 0.56, using the method of unlike signs. This low correlation casts doubt upon the reliability of these results, as it indicates a pronounced individual variation under the same conditions.

On the other hand, the difference is somewhat more significant, in view of the fact that the decrease in blood pressure for the first three days of the last week took place in 16 out of the 19 cases, and is in the direction opposite to and in spite of the fact that there may have been considerable emotional excitement due to the strangeness of the proceedings during the first week. In spite of this, which might have tended to reduce the blood pressure more in the first week than in the second, there is a decrease of blood pressure in the second week, after the ventilation had been changed.

PSYCHOLOGICAL OBSERVATIONS.

The pupils in the room described in the foregoing were tested to determine their mental progress at the same time that they were tested physically. It was important in the latter tests to eliminate the effect of increased facility which would be acquired by repetition, also to allow for fatigue which would be acquired by repetition, also to allow for fatigue which would have a tendency to reduce the amount of work the longer it continued. In order to isolate the effects of ventilation, the control group of pupils was chosen in an adjoining school, so that the average of the tests in the control group would be practically the same as that in the test group. The control group was tested in the same manner and for the same periods as was the test group, only a week later.

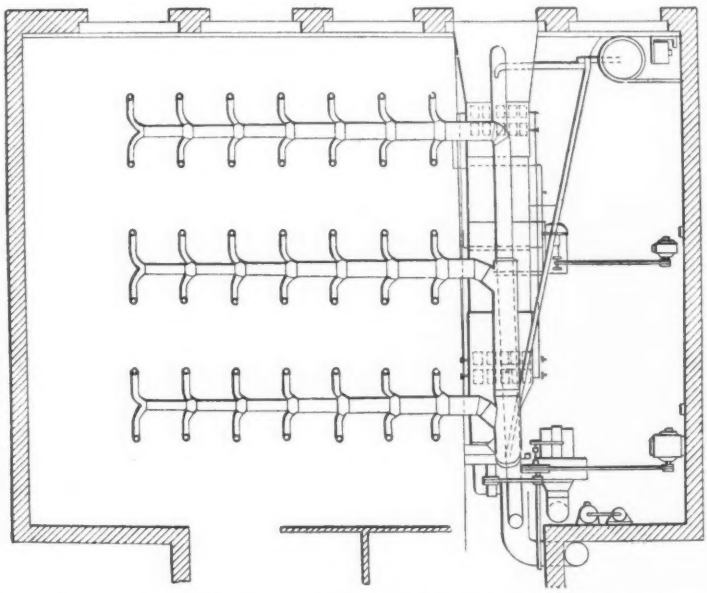


FIG. 5.—BASEMENT PLAN SHOWING LOCATION OF APPARATUS AND DUCTS ON CEILING.

It was assumed that the two groups were equally efficient in the activities required, this assumption being based on the similarity of their averages in the first series of tests. Both groups averaged the same within 1%. The work of the control group was a trifle higher in all the tests of the first series, so the assumption was made that this difference would remain constant, and, in comparing the work of the two groups for the second week it was allowed for by de-

ducting the amount of difference. This placed the two groups on the same level at the beginning of the second test week, and it was assumed that any deviation which then appeared in the work of the test group could be ascribed to effects of ventilation change. The tests were given on the last hour of the morning of each day in order to have the effect of the indoor ventilation at its maximum.

Division, substitution, and motor tests were used (described in detail by the author). Promptly at 11 o'clock A. M. the tests were started, 10 min. being devoted to each activity in the foregoing order. For the division test each child was given a paper upon which were printed 140 problems in short division.

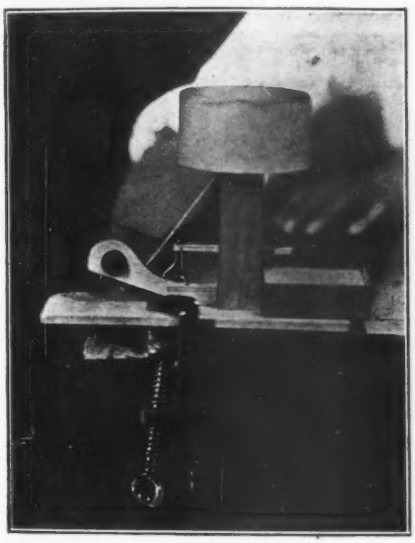


FIG. 6.—THE ERGOMETER USED.

For the substitution test a sheet of paper was given each child containing the letters of the alphabet arranged in two horizontal rows across the top. Underneath each letter was placed some number which lay between 11 and 36 inclusive. These numbers were arranged in chance order. The rest of the paper was covered with 17 rows of squares, 10 in a row, each square containing a number and a space underneath in which to insert the letter which accompanied that number in the key above. The arrangement of the numbers in the key was varied from day to day. The procedure of this test was the same as that for division.

The motor test consisted of the sidewise movement of the index finger described by Bergstrom, with a modification in the manner of holding the rest of the hand in position. It was manifestly impossible to obtain kymographic records of the work of each child, so a simple ergometer, Fig. 6, was devised which would be adapted to group tests and obtain fairly accurate measures of movement against a slight pressure (the wire agitator described below).

METHOD OF SCORING.

The method of scoring was as follows: In division, every correct solution was given a value of 3. For an error in the first figure of the quotient 2 was deducted, and for an error in the second figure 1 was deducted. For every example omitted 1½ was deducted. Under this system of scoring the highest score attained by any individual during a ten-minute period was 335, and the lowest 10.

In substitution every square correctly filled counted 1; for each substitution omitted 1 was deducted. The highest score attained by any individual during a ten-minute period was 144; the lowest 24.

In the motor test scores were obtained by weighing the total number of balls dropped by each individual and dividing by the weight of the ball. The highest score made in 10 min. was 1,093; the lowest, 123.

The tests were chosen with a view to selecting activities of as varied nature as possible, so that there might be several chances of detecting ventilation effects, and, if they were discernible, that they might be observed from several angles. That this end was attained is evident from the comparatively low correlation of the tests with each other.

After eliminating the records of all children who were absent on any of the test days and who were thus deprived of practice, together with one who was pronouncedly feeble minded, and thus unable to do some of the work, the number of records finally used out of the test group was reduced to 28 for each division and substitution. The number of motor records used out of the test group was further reduced to 17 owing to the fact that some of the children experienced difficulty with their machines while

others broke them. The control group was reduced in the same manner to 25 for division, 28 for substitution, and 19 for motor. The total amount of work done each day by the average child is as follows:

TEST GROUP WITH VENTILATION CHANGED.

	Mon.	Tues.	Wed.	Thur.	Fri.	Total	P. E.
Division:							
March 3-7	67.3	86.8	105.5	109.6	120.8	490.	154.
March 24-28	133.7	163.7	161.5	161.4	180.7	801.	220.
Substitution:							
First week	54.	63.7	68.	65.6	75.2	326.5	54.4
Second week	69.1	70.	70.	71.	70.8	351.	64.9
Motor:							
First week	Omitted	354.4	420.	459.3	468.5	1693.2	295.3
Second week	Omitted	501.	473.3	530.6	574.6	2079.5	304.5

CONTROL GROUP WITH VENTILATION UNCHANGED.

	Mon.	Tues.	Wed.	Thur.	Fri.	Total	P. E.
Division:							
March 10-17	69.5	86.	100.6	112.9	130.9	500.	147.4
March 31-April 4	107.3	111.7	129.1	139.4	139.5	627.1	186.4
Substitution:							
First week	52.5	61.2	68.8	66.	73.2	321.7	46.2
Second week	69.8	74.7	73.9	75.9	72.3	366.6	69.9
Motor:							
First week	Omitted	362.1	433.	470.7	495.8	1761.6	334.3
Second week	Omitted	518.6	554.	556.7	567.4	2196.7	98.8

For graphic representation of results, see illustrations.

Tests Show No Appreciable Effect on Work of Children.

The results of this study show that the change in ventilation made at the Jackson school produced no appreciable effect upon the work of the children in the tests with the possible exception of a slight difference in substitution work, which may be explained on other grounds. The work of the children in several forms of psycho-physical activity furnishes the basis for this conclusion: (1) solving problems in short division, a task involving a high type of selective thinking and memory processes; (2) learning to make substitutions, a task partly mental and partly motor; (3) movement of the index finger, a strictly motor act.

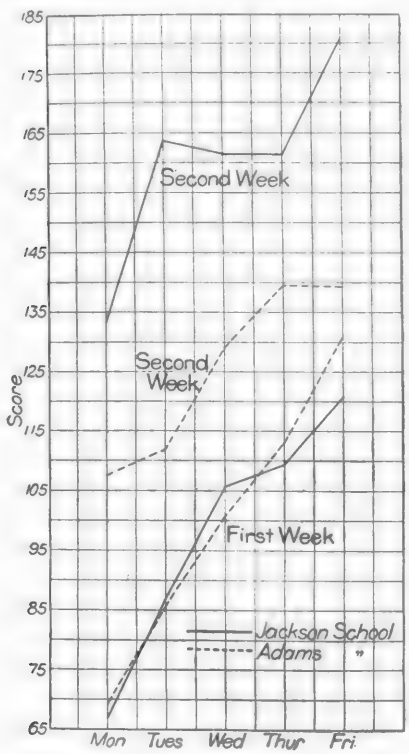
Conclusion.

From the standpoint of the engineer, it is interesting to know that it is possible to renew the air of a fully occupied school room for a period of 3 hrs. (with recess period as usual) without the use of outside air other than that which leaked through crevices and occasionally opened doors and other minor openings, and during this period to keep the air sweet and comfortable. It is further interesting to know that the continuation of this form of air renewal day after day, 5 hours each day (3 hours and 2 hours) for three weeks had no perceptible effect upon a group of school children under careful observation by expert observers making physiological and psychological determinations. The conditions in the room were such that the teacher and pupils were perfectly content and satisfied at all times and unaware of the fact that they were not being treated to the air of the street instead of the renewed air of their own room. At one time during the test the small fan supplying ozone went out of commission temporarily and the effect was noticed within 20 to 30 min. by the teacher, who felt that the air was "stuffy," although she had no way of knowing of the accident. Apparently in this case the ozone was an important factor in keeping the air of the room in a comfortable condition. Ozone has an affinity for water vapor, and, if there were enough of it, humidity might be reduced by it, but in this ex-

periment there was not enough ozone to affect the humidity materially. The humidity due to evaporation from the pupils may have been partially removed by condensation on the cold surfaces of the distribution pipes in the basement and by the air leakage from the room.

The psychological tests were evidently very carefully planned and executed; their value for such work cannot be doubted, for their delicacy is admirably fitted to detect and measure the elusive effects which have been usually described as "sense of oppression," "dullness," "restlessness," "sleepiness," and others due to poor ventilation. The work done by Mr. Kitson in analyzing and arranging and correlating his observations indicates a standard of completeness not often reached in tests of ventilation conducted outside of laboratory conditions, but it is work of a character worthy of consideration in the preparation of standard psychological or physiological field tests.

The physiological tests made by Dr. Huenekens were quite complete so far as they went, but circumstances made it impossible to make blood counts or hæmoglobin tests as would have been desirable. There is undoubtedly a large undetermined personal equation in the blood pressure determinations. The temperature observations lead to no valuable conclusions.



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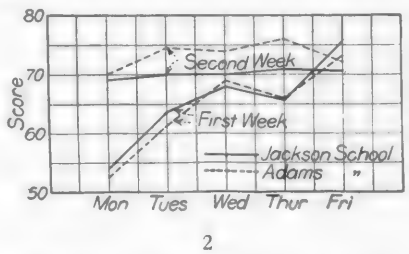

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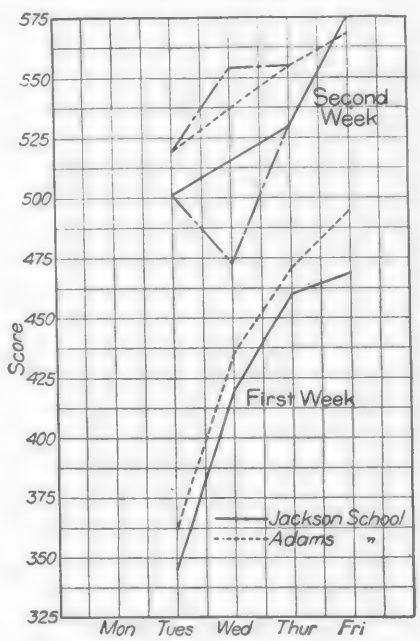
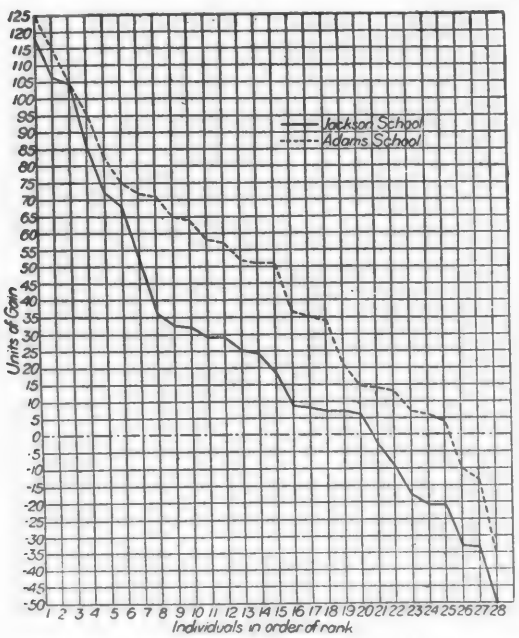


3

CURVE I.—SHOWING RECORD OF DIVISION TESTS. CURVE 2.—SHOWING RECORD OF SUBSTITUTION TESTS. CURVE 3.—SHOWING RECORDS OF MOTOR TESTS.

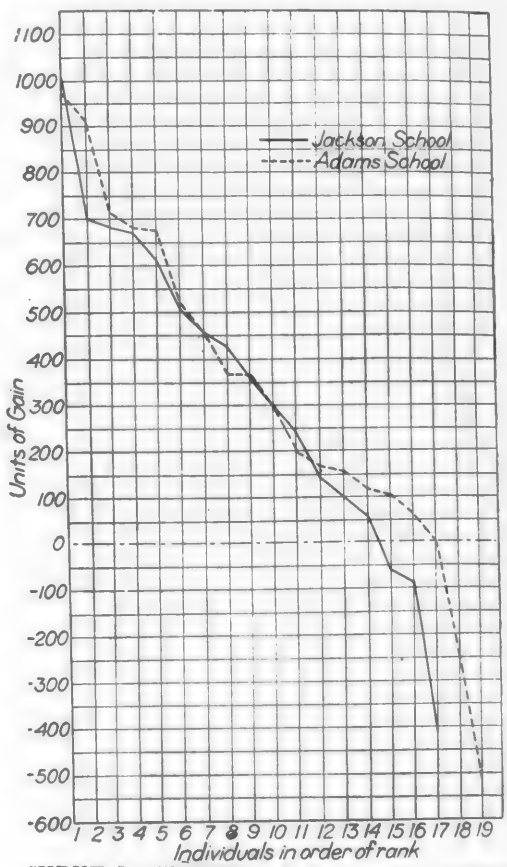
The apparatus for the experiment delivered to each child, whether at his seat or at the blackboard, a refreshing current of cool air, with a small quantity of ozone. The humidity was moderate, averaging 32.6%, as was the temperature averaging 68.8° F. The velocity of the center of the air current 2 ft. away from the desk funnel, or at the usual position of the face, was 1½ ft. per second.

The oxygen content might have been low and the carbon dioxide content might have been high, but, since so many investigators have conclusively proven that under such conditions as obtained in this experiment, these were negligible factors, these determinations were not made. There are further desirable data that might have been taken had it been possible; the temperature and humidity of the air in the control group would have been recorded, variations in humidity each day in both groups, actual measurements of air leakage among the physical factors, blood counts, hæmoglobin tests, conditions and environment of pupils outside of school, histories among the physiological data, and more extended physiological tests. A longer period of observation would have been desirable but was impossible under local limitations.



CURVE 4.—SHOWING INDIVIDUAL SUBSTITUTION GAIN.

The results show conclusively that in rooms and auditoriums only occasionally used, such as lecture rooms, theatres, churches, not subjected to repeated occupancy by the same persons, the revolving and renewing of air by proper treatment are as desirable as the use of outside air.* Outside air ducts and indirect heating coils are entirely unnecessary. It seems probable, too, that persons may occupy rooms ventilated by renewed air for a great length of time, certainly for periods as long as three weeks, without suffering or even exhibiting any effect either consciously or unconsciously. Air leakage will supply more than enough oxygen.



CURVE 5.—SHOWING INDIVIDUAL MOTOR GAIN.

It would seem to me that the time has come when old standards of ventilation and methods of ventilating practice should be radically altered. More extensive, comprehensive, complete experiments along the lines of this limited work need to be performed, and, as a result of such experiments, a new science and a new practice of ventilation of buildings should be established.

The psychological work of this investigation was done by Mr. H. D. Kitson, M.A., and a large part of the work done and description herein are his. Any success attained has been due to his enthusiasm.

*See discussion on Page 31.

A Comparison of Thirteen Radiation Formulas

By A. C. Rogers.

Figuring from thirteen radiation formulas which had been previously submitted to the National District Heating Association by its committee on radiation, Mr. A. C. Rogers showed, in a typical case, how they varied. His computations formed part of a paper on "District Hot Water Heating for Residences," read by him at the recent meeting of the Association in Indianapolis.

The formulas were as follows:

FORMULA NO. 1.

$$R = \left\{ \frac{22\ (W\text{-}G) + 72\ (G) + 2.8\ (C)}{150} \right\}$$

FORMULA NO. 2.

$$R = 1.6 \left\{ \frac{W\text{-}G}{20} + \frac{G}{2} + \frac{C}{200} \right\}$$

FORMULA NO. 3.

$$R = 0.4 \left\{ \frac{W}{4} + G + 0.04C \right\}$$

FORMULA NO. 4.

$$R = 0.0082 \left\{ 75 \left(\frac{W\text{-}G}{5} + G \right) + C \right\}$$

FORMULA NO. 5.

$$R = \left\{ \frac{W\text{-}G}{10} + \frac{G}{1} + \frac{C}{200} \right\}$$

FORMULA NO. 6.

$$R = \left\{ \frac{26\ (W\text{-}G) + 86\ (G) + 2.8\ (C)}{165} \right\}$$

FORMULA NO. 7.

$$R = 0.0092 \left\{ 75 \left(\frac{W\text{-}G}{10} + G \right) + C \right\}$$

FORMULA NO. 8.

$$R = \left\{ \frac{33\ (W) + 80\ (G) + 2.8\ (C)}{160} \right\}$$

FORMULA NO. 9.

$$R = 1.1 \left\{ \frac{75 \left(\frac{W\text{-}G}{10} + G \right) + C}{100} \right\}$$

FORMULA NO. 10.

$$R = 0.14\ (W\text{-}G) + 0.7\ (G) + 0.0073\ (C)$$

FORMULA NO. 11.

$$R = \left\{ \frac{75 \left(\frac{W}{8} + G \right) + C}{100} \right\}$$

FORMULA NO. 12.

$$R = 1.87 \left\{ 0.05\ (W) + 0.5\ (G) + 0.005\ (C) \right\}$$

FORMULA NO. 13.

$$R = 0.48 \left\{ \frac{W}{4} + G + \frac{C}{55} \right\}$$

In the above formulas,

W represents exposed wall in square feet.

G represents glass (doors and windows) in square feet.

C represents cubic contents in cubic feet.

R represents direct radiation (cast-iron) in square feet.

The plan used in the calculations gave the accompanying data (page 26):

The data given is figured from the formulas given, all being used by various concerns and being more or less standard. Numbers 1 to 13 inclusive give the radiation as figured by the formulas bearing that number while number 14 represents the average of all computations. All are figured on zero—70° F. basis.

The above formulas are not complete, some having various constants, but are here given as based on 70° F. inside temperature and average construction. It will be noted that formulas 1, 6 and 8 are what are termed B.T.U. or transmission loss formulas, and formula 3 calls for two air changes per hour. It seems probable that the other formulas take an average of 1½ changes of air per hour as their value for C.

Again referring to formulas 1, 6 and 8, we can see by the denominator or divisor that each has a different value, this divisor representing heat unit loss per square foot of direct radiation per hour.

Formula 1 gives 150 heat units as the value for loss, which is for gravity work, and is, I believe, fair and generally rec-

ognized as standard. On the other hand, the authors of formulas 6 and 8 give higher emission rates and these formulas are evidently based on district heating standards.

heating company. This practice will insure good service and good results.

Again, if we adopt the same standard for gravity and district work, we shall find that houses originally fitted for grav-

WATER RADIATION by CARPENTER'S RULE

$4(\frac{W}{T} + G + .02NC) \cdot R$ W = ex wall G = Glass - C = cubical Contents

"N" Air Changes Per Hour - 4 Constant

All Figures for 70° - Note. - Figures are sq Feet of Radiation

Quantity	WALL	GLASS	Cubic 1-N	Cubic - 2-N	Cubic - 3-N	Cubic 4-N
1	.1	.4	.008	.016	.024	.032
2	.2	.8	.016	.032	.048	.064
3	.3	1.2	.024	.048	.072	.096
4	.4	1.6	.032	.064	.096	.128
5	.5	2.0	.040	.080	.120	.160
6	.6	2.4	.048	.096	.144	.192
7	.7	2.8	.056	.112	.168	.224
8	.8	3.2	.064	.128	.192	.256
9	.9	3.6	.072	.144	.216	.288
10	1.0	4.0	.080	.160	.240	.320
20	2.0	8.0	.160	.320	.480	.640
30	3.0	12.0	.240	.480	.720	.960
40	4.0	16.0	.320	.640	.960	1.280
50	5.0	20.0	.400	.800	1.200	1.600
60	6.0	24.0	.480	.960	1.440	1.920
70	7.0	28.0	.560	1.120	1.680	2.240
80	8.0	32.0	.640	1.280	1.920	2.560
90	9.0	36.0	.720	1.440	2.160	2.880
100	10.0	40.0	.800	1.600	2.400	3.200
200	20.0	80.0	1.600	3.200	4.800	6.400
300	30.0	120.0	2.400	4.800	7.200	9.600
400	40.0	160.0	3.200	6.400	9.600	12.800
500	50.0	200.0	4.000	8.000	12.000	16.000
600	60.0	240.0	4.800	9.600	14.400	19.200
700	70.0	280.0	5.600	11.200	16.800	22.400
800	80.0	320.0	6.400	12.860	19.200	25.600
900	90.0	360.0	7.200	14.400	21.600	28.800
1000	100.0	400.0	8.000	16.000	24.000	32.000
2000	200.0	800.0	16.000	32.000	48.000	64.000
3000	300.0	1200.0	24.000	48.000	72.000	96.000
4000	400.0	1600.0	32.000	64.000	96.000	128.000
5000	500.0	2000.0	46.000	80.000	120.000	160.000
6000	600.0	2400.0	48.000	96.000	144.000	192.000
7000	700.0	2800.0	56.000	112.000	168.000	224.000
8000	800.0	3200.0	64.000	128.000	192.000	256.000
9000	900.0	3600.0	72.000	144.000	216.000	288.000
10000	1000.0	4000.0	80.000	160.000	240.000	320.000
20000	2000.0	8000.0	160.000	320.000	480.000	640.000
30000	3000.0	12000.0	240.000	480.000	720.000	960.000
40000	4000.0	16000.0	320.000	640.000	960.000	1280.000
50000	5000.0	20000.0	400.000	800.000	1220.000	1600.000
60000	6000.0	24000.0	480.000	960.000	1440.000	1920.000
70000	7000.0	28000.0	560.000	1120.000	1680.000	2240.000
80000	8000.0	32000.0	640.000	1280.000	1920.000	2560.000
90000	9000.0	36000.0	720.000	1440.000	2160.000	2880.000
100000	10000.0	40000.0	800.000	1600.000	2400.000	3200.000

VALUES IN SQUARE FEET OF HOT WATER RADIATION FOR WALL, GLASS AND CUBIC CONTENTS (WITH ONE TO FOUR CHANGES OF AIR PER HOUR).

I must take issue with this view, believing that a high radiation formula, with low rate for heating, is the ideal condition, both from the customer's standpoint, as well as from that of the

ity can be taken on a district heating system without materially varying the service. Also, if one of our customers for any reason should go back to gravity heating, he would have an economical

DATA FROM PLAN.

	Width, Ft.	Length, Ft.	Height, Ft.	Exposure	Windows
Room "A"	15	15	10	1 end 2 sides	3
Room "B"	15	30	10	1 end ½ sides	2
Room "C"	7½	30	10	2 end 1 sides	1
Room "D"	15	15	10	1 end	1
Room "E"	15	15	10	1 end 1 sides	2

	Cubic Contents, Sq. Ft.	Exposed Wall, Sq. Ft.	Glass Area, Sq. Ft.	W-G
A	2250	450	90	360
B	4500	300	60	240
C	2250	450	60	390
D	2250	150	30	110
E	2250	300	60	240
	13500	1650	300	1350

FORMULA NUMBERS AND RADIATION RESULTS OF EACH—

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	138	119	117	118	137	142	108	177	129	130	110	147	117	130
B	148	103	126	103	107	145	99	171	119	108	118	126	104	121
C	128	97	105	103	110	131	89	162	116	113	110	119	102	114
D	74	52	63	52	53	73	50	86	59	54	59	63	52	61
E	106	85	90	85	95	107	79	131	94	92	96	105	84	96
	594	456	501	461	502	598	425	727	507	497	493	560	459	522

heating plant, as far as radiation is concerned.

It will also be noted that these formulas as given and worked out in connection with the same plans, vary from a minimum of 425 sq. ft. to a maximum of 727 sq. ft. It seems that this latter figure is based on 10° F. below zero. In that case, for zero it would be about 635 sq. ft. and the average would be 515 sq. ft. as against 522 sq. ft. It must not be overlooked that some of these formulas are used in warm localities, as compared with some northerly portions of the country. It will also be seen that the formulas giving low radiation have higher temperature schedules.

Novel Method of Finding Heat Loss Demand.

In the department with which the writer is connected, we had a job of measuring and surveying all the buildings on the system. In working out the heat loss demand, for which we charge, a lot of work was encountered using one of the formulas here given. To reduce the the work as much as possible and to avoid errors, all work, after measuring the house, was reduced to a few figures in addition.

This was done by getting the value in square feet of radiation for each foot and multiple of exposed wall, glass and also cubic feet of contents. I have prepared a sheet, given herewith, worked out by this method, using Prof. R. C. Carpenter's well-known formula, giving values of cubic contents for one, two, three and four changes of air.

It will readily be seen that by taking off the quantities for each item of wall, glass and cubic contents, the radiation for which is readily found, and by adding these values, the radiation sought is the result of this sum.

So far as the writer knows, this is original with our department and I would suggest it as a very good method and time-saver, as well as a check against errors.

Current Heating and Ventilating Literature

Electrical Heating

Electrical Heating. Discusses efficiency meaning of an ideal heating system, giving report of a test made of a luminous electric radiator. 2000 w. Elec Rev, Lond —June 13, 1013. 40c.

Heating

Steam Loop and Gravity-Return System. J. C. Hawkins. Shows the piping of a steam plant in which the steam loop has taken care of the condensation with good results. 2000 w. Power—June 17, 1903. 20c.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Proceedings of Midsummer Meeting, Buffalo, N. Y. July 17-19, 1913

The broadening vision of The American Society of Heating and Ventilating Engineers, which has been so much in evidence during recent years, was further exemplified at the society's summer meeting in Buffalo, N. Y., June 17-19. In addition to the quality of the papers presented, which were characterized by Prof. John R. Allen as a striking commentary on the advances made in the development of heating and ventilating during the past dozen years, the meeting had the pleasure of listening to a description of the work of the newly-created Industrial Board in New York State, especially with reference to the development of good ventilating methods in the industries. Another talk by the president of the National District Heating Association showed the cordial attitude of that organization and its desire for close co-operation with the heating engineers' society in furthering the interests of both bodies. Finally, some idea of the scope and importance of the work undertaken by the recently-appointed New York State Ventilation Commission was presented to the members and their aid asked in supplying suggestions or in other ways helping to make the commission's findings of practical, as well as scientific, value.

President John F. Hale called the meeting to order Thursday morning in the ball room of the Hotel Statler. After greeting the members and guests he said the selection of Buffalo as the meeting place was largely in response to the very urgent invitations extended by those manufacturers whose plants and laboratories are situated there and from whom the society will receive assistance in solving some of the problems it has under consideration. He also called attention to the fact that the programme for the meeting was made up largely of papers written by men of the central west.

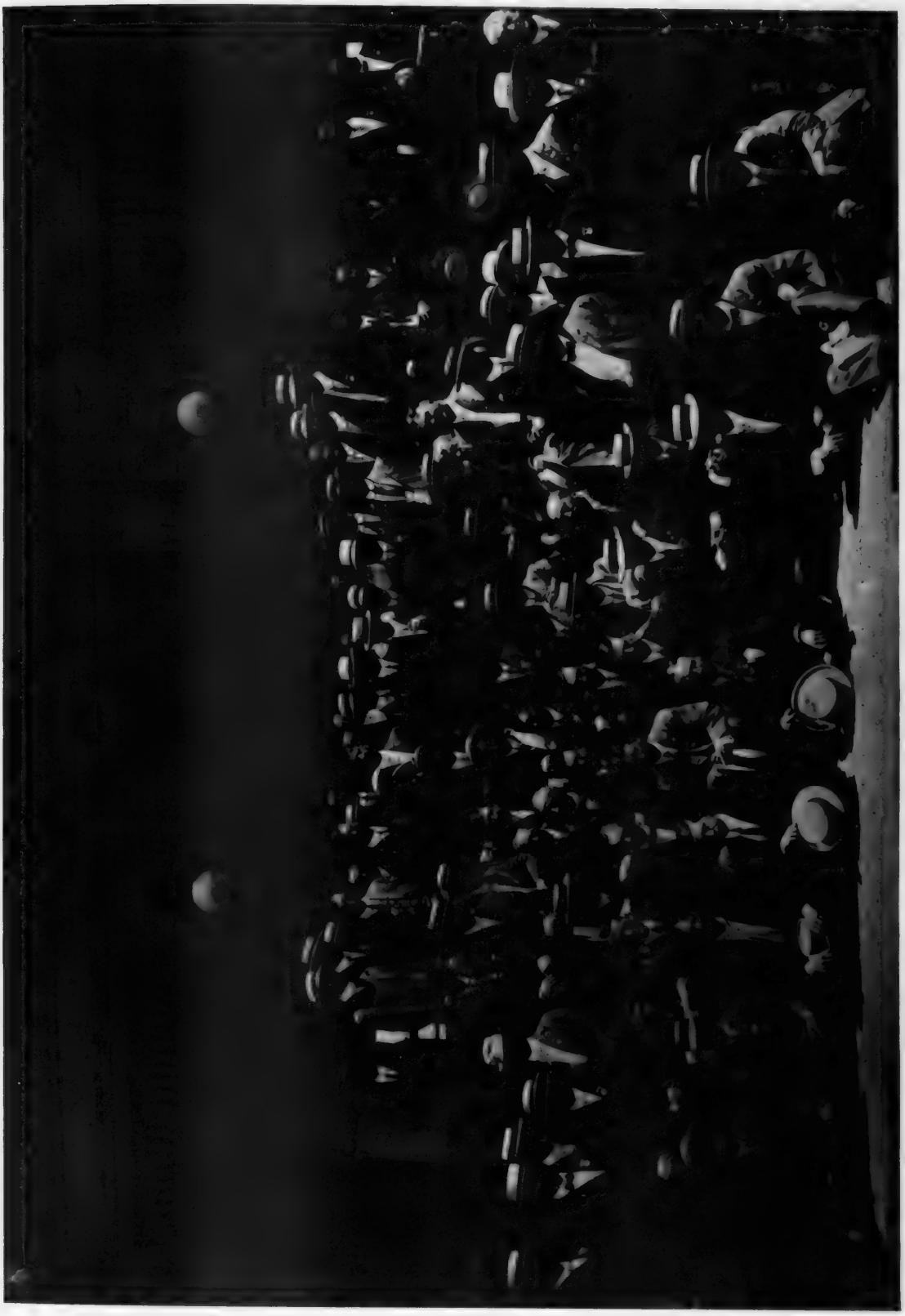
"The unique feature of this meeting," he continued, "is the visit to the Institute of Thermal Research where our hosts will place at our disposal both steam and hot water heating boilers, blast coils and heating systems, all set up for testing purposes, so that we may observe their operation and be better able to follow the papers to be read.

"At the beginning of this administration the membership was 449, to which was added 27 by the election of June 27, 1913. There have been three resignations, two deaths and four failures to qualify, making the total membership 467 on July 3, 1913. Ten applications for membership are in the hands of the membership committee and as many more have expressed their intention of applying." President Hale concluded by bespeaking a more hearty co-operation on the part of the membership, especially in committee work.

Secretary Edwin A. Scott read a cablegram received from Frank T. Chapman and Former Secretary W. W. Macon, dated at Leipzig, Germany, expressing their best wishes for a successful meeting.

The secretary stated that he was busy on the volume of the proceedings for 1912 and that it would be ready for delivery in three or four weeks. He also announced that an effort would be made to publish the proceedings of the present year by next December. The council has arranged for a wider distribution of the society's proceedings through the technical bookdealers.

In connection with committee work,



MEMBERS AND GUESTS OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS AT THE INSTITUTE OF THERMAL RESEARCH, BUFFALO, N. Y., JULY 16, 1913.

Mr. Scott stated that the question of compulsory ventilation was coming up in Delaware next year.

Following the reading of Chapter reports detailing the activities of the Illinois and New York Chapters, the secretary announced the election of the following new members:

Clinton E. Beery, Board of Education, Rockford, Ill.
Virgil L. Brooks, 42 N. Jefferson St., Dayton, O.
Chas. W. Christian, 407 E. Boulevard, Charlotte, N. C.
E. J. Claffy, 14 W. Illinois St., Chicago, Ill.
Frank J. Douglas, 100 N. Dearborn St., Chicago, Ill.
F. R. Ellis, B. F. Sturtevant Co., Hyde Park, Mass.
Milton W. Franklin, M. D., General Electric Co., Schenectady, N. Y.
Chas. A. Fuller, 80 Maiden Lane, New York.
F. E. Giesecke, University of Texas, Austin, Texas.
H. G. Isserteil, 527 W. 34th St., New York.
August A. Kieb, 18 Pacific St., Newark, N. J.
William M. Kingsbury, 9212 Wade Park Ave., Cleveland, Ohio.
W. S. Koithan, 39 Cortlandt St., New York.
Geo. A. MacKenzie, Western Foundry & Metal Co., Calgary, Alta.
Thomas F. McCoy, 220 Congress St., Boston, Mass.
C. T. Morse, 607 Canadian Express Building, Montreal, Que.
Arthur K. Ohmes, 103 Park Ave., New York.
S. H. Pool, 5 Market St., Lynn, Mass.
R. W. Pryor, Jr., 39 Cortlandt St., New York.
Eugene R. Stone, 139 Pearl St., Boston, Mass.
William W. Underhill, 139 Pearl St., Boston, Mass.
James D. White, B. F. Sturtevant Co., Hyde Park, Mass.

ASSOCIATES.

J. B. Collins, 1508 Texas Ave., Houston, Texas.
Roswell L. Douglass, B. F. Sturtevant Co., Hyde Park, Mass.
Louis Helmer, 200 W. 69th St., New York.
William E. Marquam, 445 Plymouth Place, Chicago, Ill.
Thomas Wilson, 505 Pearl St., New York.
C. A. Yokom, 349 Security Bank Building, Minneapolis, Minn.

An important interim committee report was then read by E. A. May, chairman of the Committee to Consider Uniform Method for Testing House Heating Boilers. Mr. May presented a proposed code to be determined from three series of tests on each boiler, covering the varying conditions under which boilers are ordinarily operated. He suggested that the ratings follow the method recommended by the American Society of Mechanical Engineers. Mr. May presented the proposed code in detail, enumerating, under various headings, the points to be covered. On motion of Prof. James D. Hoffman, it was voted that the committee's report be printed and forwarded to the members for their approval or disapproval. The motion included the provision that the A. S. M. E. code be included in the report.

In connection with the work of the Committee on Tests, James A. Donnelly suggested that the Bureau of Standards, at Washington, could be induced to make tests on radiators, for instance, of various widths, heights, etc., with a view of determining the proper coefficients of heat transmission for the various styles in commercial use. R. C. Taggart suggested, as other lines on which tests should be conducted, the drop in steam pressure in elbows and the velocity of steam through pipes.

For the Committee on Compulsory Legislation, General Chairman James D. Hoffman spoke of the efforts of his committee to complete the draft of a model compulsory ventilation law and stated that the model law, as revised in accordance with the suggestions made at the last annual meeting, would shortly be sent by mail to the members. He gave it as his opinion that a number of States would have passed compulsory ventilation laws if the society had agreed on a model bill. Mr. Weinshank endorsed this statement, especially with reference to the situation in Indiana.

NEW COMMITTEES.

Announcement was then made of the appointment of the following new committees:

Committee on Use of Pitot Tube for Measuring Air Velocities at Air Supply Openings: J. I. Lyle, chairman; S. R. Lewis, W. L. Bronaugh, J. D. Hoffman, F. R. Still and F. L. Busey.

Committee to Represent Society at National Conservation Congress: Henry Adams, chairman; N. S. Thompson and M. S. Cooley.

Committee to Represent Society at the International Congress on School Hygiene: Frank Irving Cooper, chairman; N. L. Patterson, S. R. Lewis, D. D. Kimball and C. B. J. Snyder.

Under new business, James A. Donnelly introduced a number of proposed amendments to the constitution, in order to make it conform more closely to the society's charter. These included the fixing of the date of the annual meeting for the third Tuesday in January and a number of details of organization, methods of voting, etc. He called attention to the fact that from a legal standpoint past presidents are not eligible to be members of the council unless specifically elected to that office.

On motion the proposed amendments, as presented by Mr. Donnelly, were approved and will, therefore, be submitted to the members for mail ballot.

Afternoon Session, July 17.

The first professional paper was presented at the afternoon session, entitled "Time Analysis in Starting Heating Apparatus," by Ralph C. Taggart. Mr. Taggart presented a new formula for determining the length of time required for bringing up indoor temperatures from zero or below to 70° F., from which he showed how the required additional boiler capacity should be figured to accomplish this.

This paper was followed by one on "Expense of Operating Heating and Ventilating Plants," by H. M. Hart, detailing computations of the operating cost of heating and ventilating in advance of construction. Figures were included giving actual results in ten residences, three school houses and two office buildings. In the latter case the theoretical fuel consumption in one of the office buildings was compared with that actually used, the results agreeing to a surprising degree.

A break in the programme was here made, a topic for discussion being introduced by M. S. Cooley on "Ventilation and the Open Window," in which three tests of rooms so ventilated failed to show satisfactory results as compared with similar rooms supplied with heated air.

Frank L. Busey then read a paper on "Loss of Pressure Due to Elbows in the Transmission of Air Through Pipes or Ducts," giving results with eleven different arrangements of piping running from a simple square turn to an offset five times the width of the pipe and having a special venturi elbow. The tests showed the notable savings effected, in many cases, by the use of venturi style elbows.

A paper followed by Prof. Frederick Bass, of the University of Minnesota, detailing "Experiments in School Room Ventilation with Reduced Air Supply Through Individual Ducts." A written discussion from Mr. Shepherd of the Chicago Normal School showed his agreement with the conclusions of Prof. Bass as to the low air quantities required under the conditions given. Mr. Hart felt that the same results could have been procured with oscillating fans, operating in connection with ozone machines.

Prof. Hoffman stated that the experiments were practically a recommendation for the ozonator.

J. I. Lyle thought it would be impossible to hold down the humidity with the arrangement as described, unless there was considerable air leakage through doors and windows. He also called attention to a reference to the ozone machine as a dehumidifier and said that, so far as he had been able to find out, ozone had no such effect on the humidity. He also referred to the operation of the system when the children are not in their seats, which, he said, would completely change the results obtained.

On motion of Samuel R. Lewis a vote of thanks was tendered to Prof. Bass for his paper and it was also voted to send Prof. Bass a transcript of the discussion with a view of securing some revision of his conclusions.

Visit to Institute of Thermal Research.

Tuesday morning was devoted to the much-anticipated trip to the Institute of Thermal Research, conducted at its Pierce plant in Buffalo by the American Radiator Company. The party filled two specially-chartered trolley cars and saw much of Buffalo's residential district on its way to the institute.

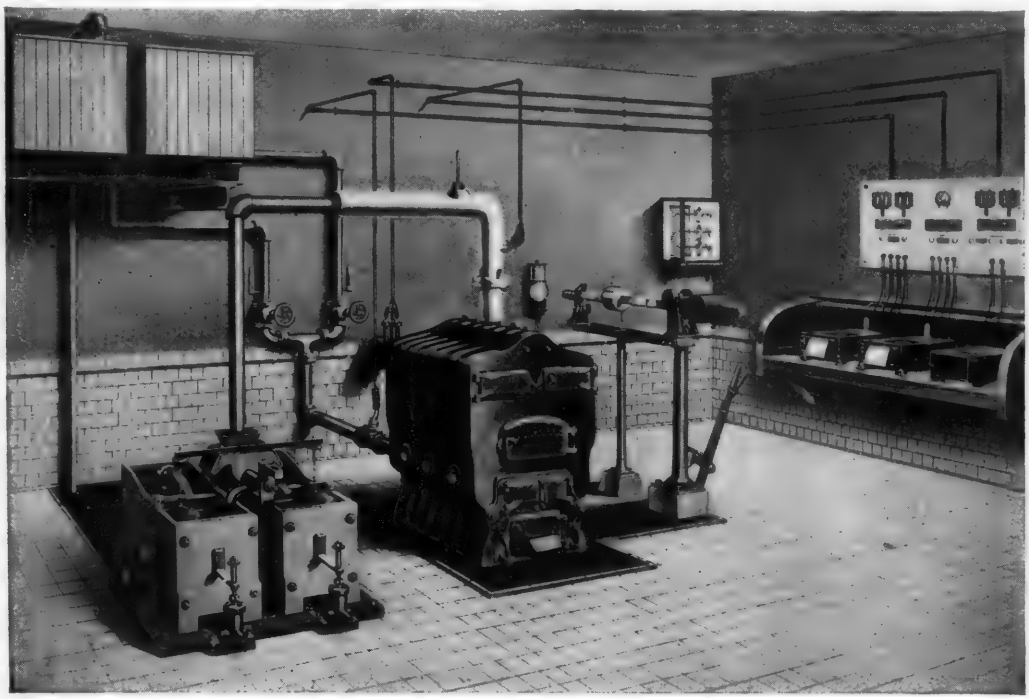
On arrival, the delegation passed upstairs to the institute's assembly hall, where Assistant General Manager of Sales Frank B. Howell, who is in general charge of the investigations carried on at the institute, explained that the members would first be taken through the building in a body and could then further inspect any particular test or arrangement of apparatus that interested them. He announced with regret the absence, on account of illness, of Dr. C. B. Thompson, who has supervised most of the tests conducted at the Institute.

Acting on this suggestion a visit was paid to the top floor where a test of pipe coils, operated in connection with a fan blast arrangement, was being made. The arrangement of the apparatus and the

conditions of the test coincided with those described in a paper, read next day by L. C. Soule, on "Heat Transmission with Pipe Coils and Cast-Iron Heaters Under Fan Blast Conditions," and was designed to afford the opportunity for making notes to be used in the discussion of the paper. Mr. Soule was present and explained the arrangements in detail.

Under the escort of the society's hosts, who in addition to Mr. Howell, included J. H. Davis, manager of the company's Vento department; Edwin A. May, the company's boiler expert, and L. C. Soule, the party then passed downstairs, going by several individual rooms, each containing a radiator, forming part of a one-pipe steam heating system, supplied by an Ideal round boiler. On the floor below were the remaining radiators, all of which were supplied from a 2-in. steam main, but with branches ranging from 1-in. diameter for 100 sq. ft. of radiation to 1½-in. for the same radiation. Glass sections were inserted at various points in the piping and the surging of the water of condensation through the smaller branches was easily noted, showing their insufficient capacity for the load assigned them.

The next point visited was the boiler testing room, where L. B. Cherry was in charge. Here different styles of the company's boilers were connected up for various methods of testing. In one case the steam was exhausted direct to the atmosphere and the capacity was determined by weighing the condensation, observation being made of other necessary items.



ARRANGEMENT FOR TESTING HOT WATER BOILERS AT THE INSTITUTE OF THERMAL RESEARCH, BUFFALO, N. Y.

A test of particular interest was one conducted on two hot water heating boilers. In one case the boiler was fed with water at a temperature of 150° F. and the temperature of the water coming out was 190° F. The boiler was being run on an 8-hr. coaling period. In the other case cold water was used and the temperature taken as it left the boiler. It was stated that in every case the results of the tests showed a rating in excess of that given out by the company in its catalogue matter.

The accompanying illustration shows, in a general way, the arrangement of

the hot water boiler test in which water at a fairly high temperature was used. The left hot water tank and the right cold water tank, located together in the upper left corner of the picture supply the boiler with water, the temperature and quantity of which is under the control by valves located in the two-pipe yoke between the back of the boiler and the two tanks. The temperature of this return water is continuously taken with a thermometer, shown inserted in the return water pipe at the lower back of the boiler. A similar thermometer, shown inserted in the flow pipe just above the top of the boiler, takes the temperature of the flow water. Other observations included draft and the weighing of the quantity of the flow water out of the boiler.

The flow water pipe was suspended over and discharged alternately into twin weighing buckets, shown in the left-hand corner of the picture. Each bucket, after receiving an exact weight or quantity of water, dumps into a tank beneath the floor. In doing so, it automatically tilts the water chute, suspended on trunnions just over the buckets and just under the mouth of the flow pipe, diverting the flow water into the empty bucket. This action tallies one on a mechanical counting machine, which is connected and geared to register each time either bucket dumps.

The hot water from the buckets (in the tank under the floor) is lifted by means of a small electric rotary pump into the upper left-hand tank, from which a portion of it runs to waste through an overflow pipe near the top of the tank. The remainder flows by gravity, through the pipe attached at the bottom of the tank to the return water pipe of the boiler, passing, on its way, through the yoke already described. There it is tempered with cold water to just the desired temperature before entering the boiler.

Further refinements in the arrangements included apparatus for measuring the temperature, pressure and humidity of the surrounding air.

At the close of the visit a group photograph was taken of the party on the steps of the Institute of Thermal Research and, after many expressions of appreciation for the courtesies extended by the company through Mr. Howell, and the others who were on hand to explain the tests and testing apparatus to the visitors, the party returned to the hotel in the same chartered cars, arriving in time for luncheon.

Inspection of Buffalo Forge Company Plant.

The afternoon was given over to an inspection of the plant of the Buffalo Forge Company. The members were escorted from the hotel in automobiles and trolley cars by H. W. Wendt, in his own car, and by Willis H. Carrier and J. I. Lyle. On arrival at the plant other representatives of the company were on hand and the visitors were divided into squads.

The first department visited was that devoted to the manufacture of the Spiro high-speed steam turbines. A 180-H.P. unit, the first ever built by the company, was on exhibition and was started going for the benefit of the visitors. The interesting statement was made that the Spiro turbines have now been developed to a point where the steam consumption for a 100 H. P. unit is within 30 to 32 lbs. per brake horse power. Spiro turbines were also shown under construction, one machine being reached as it was cutting a herringbone gear for one of the larger units, the material used being manganese cast-iron.

In the Carrier air washer department a number of large units were shown in various stages of completion, some being made entirely of copper, having an air capacity of some 50,000 cu. ft. per minute. It was stated that the company had recently shipped an air washer capable of handling 212,000 cu. ft. per minute.

The visitors then saw how Conoidal fans are made, also high pressure fans, for cupola and similar work, some operating under 18 oz. air pressure.

The company's extensive business in the manufacture of forge blowers and blacksmiths' tools was shown on the upper floors visited. At the conclusion of the inspection the party was given an interesting talk on the Carrier differential thermostat, by which both the temperature and humidity may be automatically regulated. Mr. W. H. Carrier described the construction and operation

of this device, a typical installation having been made in this part of the plant, permitting a thorough inspection of this remarkable instrument.

The visit consumed most of the afternoon, the members reaching headquarters in time for the boat ride to Grand Island.

Morning Session, July 19.

Before calling for the regular order of the Saturday morning session, President Hale called to the rostrum Prof. John R. Allen, formerly president of the society who has recently returned from Constantinople. Prof. Allen said that the character of the papers read at the present meeting were a striking commentary on the advances made in the development of the art of heating and ventilation during the past dozen years. He said that even though this were so, it is nevertheless a fact that we do not yet know what is good ventilation. We have no standard or accepted method of making such tests. We also have but little fundamental information on heat losses from buildings, and the actual amount of radiation required in a given case is not a settled question.

Prof. Allen stated that American practice in heating and ventilating engineering has gone much farther than English practice. In England, he said, hot water heating is used almost exclusively, as compared with steam heating. English engineers know practically nothing of one-pipe work. In Germany the theory has been developed to a point beyond that known in this country, but German practice and methods of installation have not reached the same stage of perfection as in America.

"But there is still a great deal to be done," concluded Prof. Allen, "and I look to see much of this work accomplished by the American Society of Heating and Ventilating Engineers."

President Hale also called on S. Morgan Bushnell, of the Illinois Maintenance Company, who is president of the National District Heating Association. Mr. Bushnell expressed the desire of the central station heating men for close cooperation with the heating engineers' society. He spoke of the committees that had been appointed by both organizations which were termed educational committees as a step in this direction. The National District Heating Association," he said, "is working along the lines of the practical needs of the heating companies, though not as scientifically, perhaps, as the heating engineers' society. We need all the co-operation and assistance we can get from heating engineers.

"There has been a great change in the past 25 years in the attitude of the practical man towards the college man, so called. College men used to be considered as theorists. To-day that attitude is completely changed. In the electrical field, for instance, there has been established in Chicago a central station institute, where electrical and steam engineering is taught on a scientific basis. The students are given the opportunity both to study theory and to do shop work."

In Germany, he said, there is close co-operation between the industries and the scientific schools. "It is in line with this idea," he added, "that educational committees have been appointed from each society to take up questions bearing on heating work and work them out together. The two committees will undoubtedly get together again during the remainder of the year and will very likely obtain good results. Steam meters, for instance, are being so much improved and are now so widely adopted by central station heating companies that valuable data are rapidly being gathered, based on actual measurements. Such information will be of the utmost service to both organizations and will no doubt be one of the matters that will be taken up by the two educational committees and made available to both societies."

The first paper on the programme for this session was read by Maxwell S. Cooley of the Supervising Architect's Office at Washington, entitled, "Chart for Determining Sizes of Pipe for Gravity for Hot Water Heating Systems," based on a new formula given in the paper.

The next paper was a description of the tests with a fan blast heating apparatus on Vento heaters and pipe coils, such as were witnessed the day before at the Institute of Thermal Research. The

paper was entitled, "Heat Transmission with Pipe Coils and Cast Iron Heaters Under Fan Blast Conditions," and was read by the author, L. C. Soule. The efficiency of the Vento heaters was strikingly brought out as compared with pipe coils whose efficiency was practically equalled and in some cases exceeded by the Vento sections.

The next speaker was Dr. E. Vernon Hill, chief of the ventilation inspection department of the Chicago Bureau of Health. Dr. Hill gave a talk, illustrated by lantern slides, on the organization and work of his department. In addition to numerous card forms used to facilitate the work of the department, the slides included many views of picture theatre interiors showing, in many cases, the crude and inadequate ventilating apparatus in use previous to the establishment of the ventilation inspection department. One of the theatres, for instance, had a limited number of air supply pipes only 1-in. in diameter while the main air supply pipe for the theatre was 8-in. in diameter.

The chairman then introduced John R. Shillady, secretary of the recently created New York State Industrial Board which will supervise, among other things, the ventilating requirements for factories and workshops throughout the State. Mr. Shillady said that the New York State Department of Labor, with which the State Industrial Board is connected, will have the most money at its disposal of any such department in the country. The board began operations June 1. Its rules will have all the force and effect of law. The members of its sub-division, constituting the board of industrial hygiene, have not yet been appointed and will await the appointment of a State labor commissioner.

Mr. Shillady said it was the intention to have technical men work out the general plans of the board and that members of the heating engineers' society would undoubtedly be invited to serve on volunteer committees, though without compensation, to fix the exact needs in specific cases for ventilating standards and equipment. "In that way," he said, "we, as a board will not need to know everything, if we are able to organize the intelligence of the community."

D. D. Kimball was also called on to tell of the work of the new ventilation commission, of which he is a member, appointed by Governor Sulzer of New York. He said that the personnel of the commission included a practical sanitarian, a medical man, a physician, a laboratory man, a psychologist and an engineer. Five or six clerical assistants will be engaged, while a technical man has been secured to act as secretary.

Mr. Kimball said that the investigation would cover a period running from four to ten years. Two rooms at the College of the City of New York have been secured for experimental work. These rooms are supplied with air by a fan on the roof, the air passing through Vento heaters and an air washer. The air washer has a drying pan containing calcium chloride, and air may be sent either wet or dry to the two rooms, or wet and dry air mixed. One of the rooms will be used as an "operation" room and the other as an "observation" room. The equipment will also include steam and water jets, temperature control apparatus, an exhaust fan and by-pass connections for recirculation of the air. In the observation room, the subjects will be observed under widely varying conditions, such as while doing arithmetical work, typewriting, etc., while records will be made of the blood pressure, pulse rate, etc., in addition to the other records.

Besides this, two New York City schools will be used by the commission, having arrangements for admitting air through the floor and exhausted at the ceiling or the reverse of this; also in or out through two of the walls.

The commission will make records and engage in experiments in factory ventilation. It will collect a library of available literature on the subject of ventilation and has arranged to get in touch with all investigators who are able to contribute to the advance of the work.

Mr. Kimball said that he wanted the heating engineers' society to take a practical interest in the work and offered to represent the society in any way he could in bringing any suggestions or ideas to the attention of the commission.

Announcement was then made of the plans for the afternoon which included a trip to Niagara Falls, while a portion of the party arranged to stop at North Tonawanda to accept the invitation of the American District Steam Company to inspect its new plant at that place.

President Hale made the interesting statement that the registration was 113 of which 75 were society members, comparing with an attendance of the previous summer meeting in Detroit of 116, of which 48 were members.

A vote of thanks was then given the entertainment committee for its successful efforts in providing so enjoyable a series of diversions for both the members and the ladies. Votes of thanks were also extended to the American Radiator Company for its courtesy in opening its Institute of Thermal Research to the society and in carrying out the suggestions of the society in the way some of the tests were arranged, to the Buffalo Forge Company in opening its plant for the inspection of the members and to the American District Steam Company for its invitation to inspect its North Tonawanda works.

This brought the meeting to final adjournment.

The Entertainment.

Buffalo has many attractions as a convention city and these were utilized to the utmost by the local entertainment committee, consisting of Frank L. Busey, chairman; C. R. Bishop and W. J. Kline. The society's summer meeting always attracts a generous proportion of the members' wives and families, but this year the proportion seemed greater than usual and this could be easily attributed to the many delightful features of the entertainment programme as announced in advance of the meeting.

On the opening day, a sight-seeing automobile trip was made by the ladies to points of interest in and around Buffalo, including Delaware Park and the Pan-American Exposition grounds, while, at the same time, a special party visited the soap manufacturing plant of the Larkin Company. In the evening the entire party were taken on a 14-mile boat ride on Lake Erie to Chrystal Beach, which proved to be a second Atlantic City in respect to its many side-shows and amusement places.

On Friday, while the men were at the Institute of Thermal Research, the ladies went in automobiles to East Aurora where they inspected the Roycroft industries established by Elbert Hubbard. After luncheon at Roycroft Inn, the party returned late in the afternoon in time to join the men in a trip down the Niagara River. The start was made from Ferry Street, where the rapid current seemed to indicate imminent danger until it was remembered that the Falls were 20 miles below. The surging of the waters passed away as the broader reaches of the river came in view and, after a half hour's ride a landing was made at Grand Island. Here the party sat down to dinner at the Bedell House.

While no formal speeches were arranged for, the presence of Prof. John R. Allen, recently president of the society, who has been in Constantinople, Turkey, the past few years establishing an experimental engineering plant in connection with Robert's College, led to a request that he tell the diners something about conditions in Turkey. Prof. Allen responded with a most entertaining and instructive talk on the life and customs of the Turks, giving to most of those present a new insight into the ways of the people in that part of the world. Prof. Allen gave it as his opinion that the partition of Turkey itself had already commenced and that it was but a question of time when the country would lose its identity as a separate nation. This, he said, was an evitable result of the Turk's inaptitude for business and his extreme conservatism. Socially, Prof. Allen said he found the Turks a most delightful people and the hospitality he enjoyed in many of their homes would compare favorably with that to be found in the best of American homes.

Prof. Allen finished speaking within a few minutes of the departure of the next boat to Buffalo and, as the boats ran at somewhat infrequent intervals at that hour of the night, the festivities were immediately concluded. The return trip was made under a full moon, and this, together with otherwise perfect weather conditions, made the sail up the river one of the most charming imaginable.

Saturday morning, the ladies left early for Niagara Falls, with the intention of inspecting the chocolate candy manufacturing there. This was followed by luncheon at the Clifton House. In the afternoon, when the professional sessions of the society were over, the men joined the ladies at the Falls and then the entire party took the Gorge trip.

MEMBERS AND GUESTS PRESENT.

Homer Addams, New York.
John R. Allen, University of Michigan, Ann Arbor, Mich.
A. S. Armagnac, New York.
John H. Bacon, Jr., Cleveland, O.
C. R. Bishop, North Tonawanda, N. Y.
R. P. Bolton, New York.
D. S. Boyden, Boston, Mass.
John Boylston, Chicago, Ill.
E. P. Bradley, St. Louis, Mo.
W. L. Bronaugh, Chicago, Ill.
F. L. Busey, Buffalo, N. Y.
S. M. Bushnell, Chicago, Ill.
E. F. Capron, Chicago, Ill.
C. F. Chase, New York.
Ralph Collamore, Detroit, Mich.
M. S. Cooley, Washington, D. C.
A. G. Cripps, Akron, O.
J. H. Davis, Chicago, Ill.
J. A. Donnelly, New York.
A. C. Edgar, Newtown Square, Pa.
M. L. Foote, Columbus, O.
W. F. Goodnow, New York.
John F. Hale, Camden, N. J.
H. M. Hart, Chicago, Ill.
E. V. Hill, M. D., Chicago, Ill.
N. A. Hill, Toronto, Ont.
J. D. Hoffman, Lincoln, Neb.
D. D. Kimball, New York.
W. M. Kingsbury, Cleveland, O.
W. J. Kline, North Tonawanda, N. Y.
F. J. Lennox, New York.
S. R. Lewis, Chicago, Ill.
J. I. Lyle, New York.
R. E. Lynd, Dover, N. J.
R. E. Mackinnon, Toronto, Ont.
H. C. Mallory, New York.
W. E. Marquam, Chicago, Ill.
E. A. May, Chicago, Ill.
F. G. McCann, New York.
W. F. McDonald, Detroit, Mich.
H. B. McLelland, Chicago, Ill.
E. K. Munroe, Baltimore, Md.
C. F. Newport, Chicago, Ill.
S. H. Pool, Lynn, Mass.
J. T. Sadler, Elmira, N. Y.
E. A. Scott, New York.
L. C. Soule, Chicago.
J. M. Stannard, Chicago.
F. R. Still, Detroit, Mich.
R. C. Taggart, New York.
Theodore Weinshank, Indianapolis, Ind.
T. Wilson, New York.
A. E. Werkhoff, LaFayette, Ind.
G. E. Abbott, Buffalo, N. Y.
H. V. Ackert, Rochester, N. Y.
J. A. Bendure, Buffalo, N. Y.
William Braemer, Camden, N. J.
J. F. Brightman, Syracuse, N. Y.
W. M. Butler, Syracuse, N. Y.
W. H. Carrier, Buffalo, N. Y.
R. C. Carter, New York.
N. J. Church, Toronto, Ont.
Richard Dawson, Toronto, Ont.
C. J. Doughty, Toronto, Ont.
G. H. Drake, Buffalo, N. Y.
J. R. Drozeski, Erie, Pa.
E. C. Evans, Rochester, N. Y.
J. H. Foresman, Williamsport, Pa.
W. M. Foster, Detroit, Mich.
C. B. Foster, Buffalo, N. Y.
F. G. Gregory, Buffalo, N. Y.
C. T. Graham-Rogers, M. D., New York.
H. M. Hill, Buffalo, N. Y.
H. B. Holley, North Tonawanda, N. Y.
F. B. Howell, Chicago, Ill.
William Hutton, New York.
R. W. Hutton, Winstead, Conn.
H. D. Joyce, Buffalo, N. Y.
K. C. Kimball, Buffalo, N. Y.
E. C. Lillie, Canton, O.
J. H. Madden, Buffalo, N. Y.
H. Maltby, Williamsport, Pa.
J. F. McIntyre, Detroit, Mich.
Joseph Meehan, New York.
H. P. Mishler, Cleveland, O.
John Montgomery, Camden, N. J.
Howard Newman, New York.
H. M. Nobis, Toronton, Ont.
S. Pearson, Indianapolis, Ind.
Frank Phegley, Cleveland, O.
L. H. Prentice, Jr., Chicago, Ill.
W. S. Ransom, New York.
Richard Rouse, Jr., New York.
R. A. Sehl, Waterloo, Ont.
J. R. Shillady, New York.
E. Scholfield, Toronto, Ont.
J. E. Snellgrove, Buffalo, N. Y.
A. W. H. Spear, New York.
F. W. Spreit, Buffalo, N. Y.
B. W. Strader, New York.
W. F. Verner, Ann Arbor, Mich.
T. A. Weager, New York.
E. K. Webster, Camden, N. J.
H. W. Wendt, Buffalo, N. Y.
Ralph Winn, Toronto, Ont.
J. C. Wright, Buffalo, N. Y.
Samuel Wright. Buffalo, N. Y.

LADIES.

Mrs. J. E. Abbott, Buffalo, N. Y.
Mrs. Homer Addams, New York.
Mrs. R. P. Bolton, New York.
Mrs. F. L. Busey, Buffalo, N. Y.
Mrs. W. L. Bronaugh, Chicago, Ill.
Mrs. S. M. Bushnell, Chicago, Ill.
Mrs. E. F. Capron, Chicago, Ill.
Miss Capron, Chicago, Ill.
Mrs. W. H. Carrier, Buffalo, N. Y.
Mrs. M. S. Cooley, Washington, D. C.
Mrs. Ralph Collamore, Detroit, Mich.
Mrs. J. H. Davis, Chicago, Ill.
Mrs. John F. Hale, Camden, N. J.
Mrs. E. V. Hill, Chicago, Ill.
Mrs. Norman A. Hill, Toronto, Ont.
Mrs. Minnie M. Kingsbury, Cleveland, O.
Mrs. W. E. Marquam, Chicago, Ill.
Mrs. F. G. McCann, New York.
Miss J. McLelland, Chicago, Ill.
Mrs. F. Phegley, Cleveland, O.
Miss Phegley, Cleveland, O.
Mrs. G. von Rehm, New York.
Mrs. Theodore Weinshank, Indianapolis, Ind.
Miss Anna Weinshank, Indianapolis, Ind.

Master Paul Kelvin Addams, New York.
Master Forbes E. McCann, New York.
Master Loren F. Marquam, Chicago, Ill.
Master William R. Marquam, Chicago, Ill.

The English Window Tax.

In middle English times the window began to flourish greatly and began to be the great means of beautifying, ventilating, and lighting the nation's houses. These being supplied with windows in plenty the Government saw a fine opportunity to replenish its exchequer. A tax was levied on the windows throughout the land. Levied in the seventeenth century, this tax brought in millions of pounds annually of revenue to the Government.

This tax was one of the worst setbacks to the cause of sanitation England has known and it was not till the abolition of the tax in 1851 that the people ceased to cut down the number of the windows in their dwellings. It was not till this tax was abolished that the people ceased to put fewer and fewer windows in their houses or ceased to block up the windows that were already in them.

Though we cannot credit to the window all the English advance in sanitation during the latter half of the nineteenth century, it is a fact that this great advance did not commence until the very year in which the window tax was abolished—1851.—J. F. Goodchild, in The Public Health Journal.

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EVER since the prevailing ventilation standards were seriously questioned a few years ago by members of the medical profession, the attitude of the heating engineer has been that he has fulfilled the requirements as they were presented to him, that he was not supposed to be a physiologist and that if there were anything wrong with the accepted standards regarding good air supply, it was really the fault of the doctors who specialized in such matters and who should now furnish the proper prescription to work on. Given such a prescription, the heating engineer could fill it from a mechanical standpoint. This is all true, but it is also a fact that the heating engineer was of necessity forced to develop his own standards from the very meagre data at his disposal and through such development to become the sponsor and, in many cases, the defender of such standards.

However, with the rapidly-accumulating evidence that we have not yet reached the correct solution of this problem, the feeling is becoming general that the physiologists have their work cut out for them in ascertaining and defining the missing link, as it were. It is a pleasure to note that they have accepted the challenge and have already shown considerable enthusiasm in attacking the proposition. Some of the fruits of their investigations to date will be given at the forthcoming International Congress on School Hygiene, at Buffalo, N. Y., August 25-30, when no less than nineteen speakers will read papers on subjects connected more or less directly with the subject of good ventilation. On one day of the congress, a special session will be given over entirely to "Ventilation, Heat and Illumination," and among the speakers will be recognized several who have been most active in calling the attention of the heating engineers to the need of revising their standards. For instance, Dr. Luther H. Gulick, of the Department of School Hygiene of the Russell Sage Foundation, will talk on "Recirculation and Ventilation," while J. H. McCurdy, of the Y. M. C. A. Training School at Springfield, Mass., is down on the program for a talk on "Ventilation," and may be expected to give further results of the interesting ventilation experiments that are being conducted at the training school. Other speakers will include Prof. Theodore Hough, of the University of Virginia; Herbert M. Hill, city chemist, of Buffalo, and Prof. C. E. A. Winslow, of New York.

With such an array of investigators engaged in a concerted effort to solve the mystery of fresh air it is more than likely that some tangible results will follow. At any rate, it is apparent that heating engineers have in the congress an important source of information on the very matter they desired the physiologists to investigate.

THE CONSULTING ENGINEER

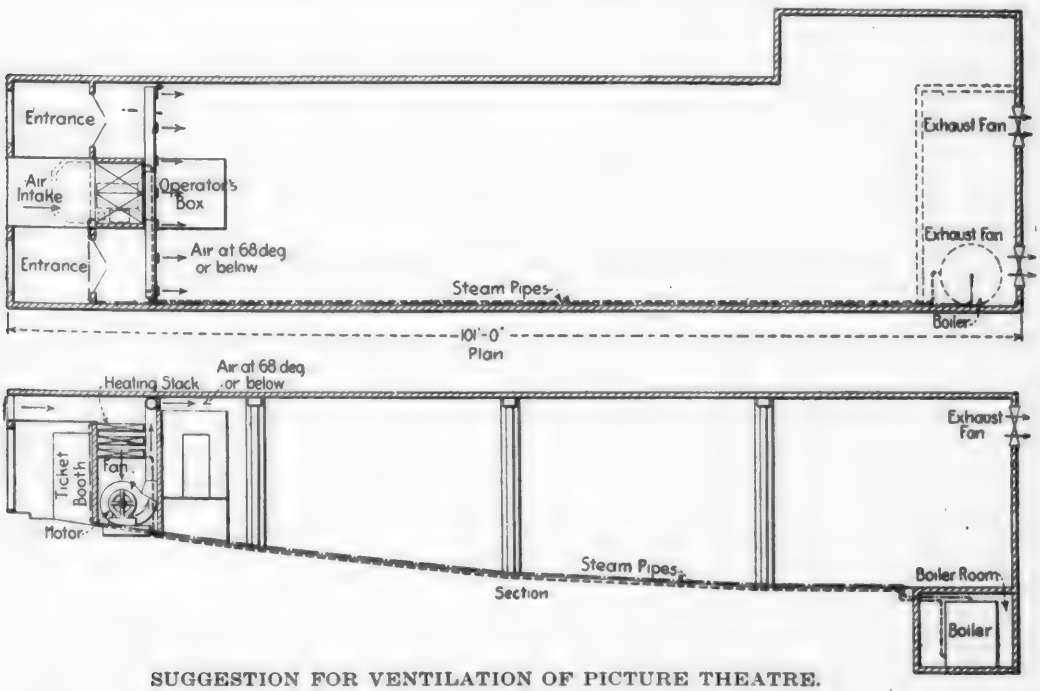
"The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

19—Picture Theatre Ventilation.

QUESTION: Will you give us some advice which we can use in connection with one of our lighting and heating customers? A month or two ago a new moving picture theatre was opened in our town and, as is very often the case, the ventilating system was taken as a matter of no great consequence. The result is that when this theatre is crowded with about 600 people the air after a few minutes is anything but good. As you will note from the accompanying sketch, the theatre is equipped with a makeshift ventilating system, but this is entirely satisfactory. The natural tendency of the draft in this building is towards the entrance. Instead of taking this into account, the architect placed two exhaust fans at the points shown on the sketch at the rear of the theatre very close to the ceiling. The only ventilation obtainable is through the opening of the rear doors, which causes a draft towards the front of the building, but with the exhaust fans running the air change is not noticeable and the system will have to be abandoned.

We would like to get your idea as to the proper location of the fans and a suggestion or two as to a good way to go about ventilating this theatre. The sketch does not show that the upper floors of this building will almost eliminate any chance of utilizing openings in the ceiling, but you need not be limited by any conditions which exist, as it is probable that some way can be found to take care of any difficulties, if somebody will just show us how to proceed.

Answer: The ventilation of an auditorium of this kind is a problem of cooling the contained air of the room, rather than one of heating, due to the heat and vapor thrown off by the occupants. The amount of heat developed by the occupants would be 400×600 or 240,000 B.T.U. per hour, or the equivalent of $240{,}000 \div 33{,}000 = 7.3$ H.P. per hour, which is sufficient to raise the



SUGGESTION FOR VENTILATION OF PICTURE THEATRE.

temperature of the room several degrees in a short space of time. The water vapor would be about $0.155 \times 600 = 93$ lbs. per hour, so the combination would make the place exceedingly uncomfortable in almost any weather.

The exhaust fans shown are in their proper position, but there is no provision for supplying air to the building, except through the doors. Sufficient air from this quarter would cause bad drafts.

It is recommended that air intakes be provided on either side of the operator's booth, which is generally near the ceiling or a mezzanine floor near the front entrance, as shown in the sketch. This opening should be at least 15 sq. ft. clear area and can probably be obtained at slight expense, without disfigurement of the front, if architecturally treated. A fan 5 ft. $\times 2\frac{1}{2}$ ft. should be provided, having a 5-ft. diameter wheel and running at about 250 R.P.M. This fan will be about 9 ft. high and will deliver 12,000 cu. ft. of air per minute at from 65° F. to 68° F. near the ceiling. This will provide 20 cu. ft. of air per minute for each occupant and is a minimum. A heater is also shown to temper the incoming air when the outside temperature is below that required for the entering air.

The heater should have 12 rows of pipe and 15 sq. ft. clear area and will be capable of raising the air from zero to 90° F. in case it is desired to heat the auditorium before the audience enters. The exhaust fan openings should then be closed and doors opened to allow the cold air at the floor to escape.

The coils may be shut off as the weather becomes warmer, so that the entering air will be at the temperature named. When the audience is present, the air at the top of the room will be foul and at an exceedingly high temperature, unless fresh cool air is provided to reduce it. The cooler air entering at the ceiling will be raised slightly as it falls to the floor, eliminating drafts. The proper temperature of this incoming air can readily be determined by experiment and may have to be somewhat cooler than the temperature named.

At times it will undoubtedly be found that the exhaust fans will not be required, or only one, especially if the outlet beyond the building is in a light area, forming a flue and the outside temperature is below freezing. Automatic heat control can be provided, with the thermostat placed as shown away from the door, if desired. The doors opening and closing will provide sufficient outward ventilation at the floor.

If a multivane type of fan is used, less head room will be required. If the floor of the fan room is on a level with the operator's booth, there will be sufficient head room for the entrance. A propeller type of fan, such as is shown for the exhaust, should not be used for the air supply, although proper for removing the foul air, as it will not work under any resistance such as occurs when the heating coil is introduced. Care should be exercised to select a fan at a sufficiently low speed so as not to make a noise and, if alternating current has to be used for power, it may be that a chain drive will have to be provided in case sufficient space is not available for a belt.

An overhead duct across the front, with openings or grills should deliver the air at from 3 to 300 ft. per minute.

The steam pipe to the coils may be run underground or under the floor of the auditorium or overhead, as may be possible from the building's construction. The return pipe may be run along the base or under the floor. The position shown for the boiler and stack will give ample fall for returning the condensation. The size of the boiler will probably have to be increased in capacity, as ventilation will take considerable steam in extreme weather. The boilers should be capable of supplying 1200 lbs. of steam per hour for the air in zero weather to raise it to 80° F., and in moderate weather of 30° F., about one-third of this power will be required. This makes a 40 H.P. boiler necessary. In moderate weather of from 30° to 40° F., about 15 H.P. will be required.

The larger boiler will be of no serious disadvantage, as it can be operated more easily, with longer periods between firing. Care should be exercised, if a cast-iron boiler is used, as the manufacturers' ratings are generally in excess of the actual capacity of the boiler under ordinary conditions of operation.

In all ordinary weather, no heat will be required, except to raise the incoming air. In case the apparatus proves too expensive as recommended, the proportions given for stack, boiler and fan will hold for any smaller air supply, but satisfactory results will be jeopardized with any smaller capacity.

In running the steam pipes, they must be arranged to drain properly, and, if a drip has to be provided at the far end near the stack, it should be carried back separately and connected in below the water line of the boiler.

In case water at a comparatively low temperature, say, 50° to 60° F. is available in summer and is cheap, the heating coils can be used for cooling the air slightly in sum-

mer by turning the water into them. An underground well of sufficient size and not too deep, with a small motor pump, would suffice to circulate the water over and over through the coils.

Legal Decisions

Installation—Defects Due to Architects' Directions.

In an action to foreclose a lien upon real estate it appeared that the plaintiffs contracted to install a heating plant in accordance with the architects' plans and specifications. They contended that they notified the owners and their architects that the plans adopted were not practicable; that certain air chambers, constructed under the architects' direction, were of insufficient size; that they in all respects followed the architects' directions; and that the fault, if any, was not the plaintiffs', but that of the architects. It was held that if the heating plant, as installed, was unfit, it was the fault of the architects, and the insufficiency was no defense to the plaintiffs' action for the price.—Ward vs. Pantages, Washington Supreme Court, 131 Pac. 642.

Fraud—Necessity to Prove Damage.

In an action to foreclose a mechanic's lien upon a hotel property it was alleged that the plaintiff contracted with the owner to install and did install a pneumatic system of temperature regulation in her hotel for $7,569, and furnished extra labor and materials in connection with the installation of the system at the agreed price of $334.50, of which sums only $4,541 had been paid. The answer denied that the labor and materials furnished were of any value. A counterclaim alleged that the defendant was induced to execute the contract through false and fraudulent representations, made by the company and relied on by the defendant, relating to the working of the system, and particularly to the effect that it would automatically shut off the heat whenever the temperature should fall below 60° F., and that, so believing, she permitted the installation, and paid the company $4,541.40 before discovering the fraud. She claimed this sum as damages. It was held that there was no proof concerning damages arising from the alleged fraud, or from which the trial court could determine that the defendant was entitled in any event to more than nominal relief. Judgment for the plaintiff was therefore affirmed.—Behrens vs. Kruse, Minnesota Supreme Court, 140 N. W. 118.

Restriction of Price of Patented Article—Jurisdiction.

Suit in equity was brought by one Illinois corporation against another for an injunction against the defendant's making and vending certain patented gas heating devices, or selling such devices of the plaintiff's manufacture at less than $1.50 each; for an account and for triple damages. The bill alleged that the plaintiff, having the sole right to make and sell the devices throughout the United States, when it sells, imposes the condition that the goods shall not be sold at less than $1.50, and attaches to the goods a notice to that effect, and that any sale in violation of the condition, or use of the article, if so sold, will be an infringement of the patent. A special pleas was lodged that the federal court was without jurisdiction, the devices having been purchased by the plaintiff from a jobber, who paid the full price to the plaintiff. The court's jurisdiction was maintained and as the defendant did not answer within the time allowed, the bill was taken as confessed and a decree entered for the plaintiff. This was affirmed by the Supreme Court, which held that the plaintiff's claim was a claim of right under the patent laws, and the circuit court properly took jurisdiction.—Fair vs. Kohler Die & Specialty Co., 33 Supreme Court, Rep. 410.

"Scaffold"—Employer's Liability Act.

A helper employed in the installation of a steam heating plant in the building of a railroad company stepped upon an unfastened plank laid upon a framework or trestle built to carry the weight of countershafts and hangers as a platform on which to run the heating pipes. The plank tipped and fell with the employé to the floor below. He sued his employer to recover damages for his injuries under the provisions of the New York Employers' Liability Act. One defense was that the planks did not constitute a scaffold under the statute, and that, if they did, it was not the defendant's scaffold, but belonged to the railroad company.

It was held that, while the defendant did not own the framework, it had rightfully the occupation, use, and control thereof for its work of suspending piping of the heating plant from the balcony overhead, and that was sufficient, without the ownership, to furnish a basis for the master's duty. It was bound to the use of reasonable care in providing its servants with a safe way and a safe place to work, and in maintaining them in a reasonably safe condition, whether the way was constructed or adopted by it. The fact that the framework

which acted as the support belonged to the railroad company in no way relieved the defendant from such duty as to the runway placed thereon. The defect causing the injury to the plaintiff was not in the framework, the substructure, but in the negligent condition of the runway, the superstructure, to the knowledge of the defendant's superintendent and foreman.—Webb vs. Sturtevant Co., New York, Appellate Division, 141 N. Y. Supp. 906.

Forthcoming International Congress on School Hygiene.

Additional details of the programme for the approaching International Congress on School Hygiene, which is to be held in Buffalo, N. Y., August 25-30, indicate that the subject of ventilation will be given a prominent place in the discussions.

Section I of the Congress, which will be devoted to "Hygiene of School Buildings, Grounds, Material Equipment and Upkeep," will devote a session on Monday, August 25, commencing at 2 P. M. to "School Buildings and Their Equipment." The programme for this session will include the following papers:

"Sanitary and Hygienic Principles that Should Control the Architecture of School Buildings," by Walter H. Killliam, architect, Boston.

"Panning School Houses Against Fire Hazard," by Frank Irving Cooper, president of the Massachusetts Chapter, American Society of Heating and Ventilating Engineers.

"One Urgent Need of a Proper System of Ventilation in School Buildings," by Dr. Melvin G. Overlock, Worcester, Mass.

The second session of Section I, on Tuesday, August 26, commencing at 9 A. M., will have as its general subject "Open Air Schools." One of the papers to be read at this session will be entitled "Window Ventilation in Pawtucket," by Dr. B. U. Richards, superintendent of the Pawtucket, R. I., Public Schools.

The general subject for the Wednesday session, August 27, will be "Ventilation, Heat and Illumination," the detailed programme being as follows:

"Effect of Conditions of School Room Heating and Ventilating," by Dr. Charles H. Keene, Minneapolis.

"Recirculation and Ventilation," by Dr. Luther H. Gulick.

"Ozone in Ventilation," by Dr. M. W. Franklin.

"Studies of Air Conditions," by Dr. C. E. A. Winslow.

"Some Phases of Ventilation," by R. D. Kimball.

"Effect of Cold Extremities on the Intellectual Activities of School Children," by Dr. Julius Brandau Kassel, of Germany.

"Ventilation," by Dr. J. H. McCurdy, of the Y. M. C. A. Training School, Springfield, Mass.

The secretary-general of the congress is Thomas A. Storey, College of the City of New York, New York.

A Hospital with Glass Rooms.

A new problem in the design of heating and ventilating equipment will be presented when Chicago's new $300,000 isolation hospital is constructed. Among the novel features of this building will be glass hospital rooms, equipped with telephones, permitting persons recovering from contagious diseases to be visited by relatives and friends. The patients, rich and poor alike, instead of being herded in wards, as is now done, are to have separate rooms, each room or cubicle to be enclosed with glass.

The hospital is to be in the Twelfth Ward, on a 27-acre site at Marshall Boulevard and 31st St., if the city is able to get title to the land. The ward buildings all to be four stories high, are to be grouped in circular shape, facing Marshall Boulevard, with the administration building in the center.

In the ward buildings, corridors 8 ft. wide in the center of each floor, are to form the means of visiting and conversing with patients. Each glass room adjoin this corridor. Outside of each room is to be a telephone instrument, protected from infection, connected with an instrument in the patient's room.

The plans have been drawn by City Architect Charles W. Kallal.

Fire Protection Wanted for Government Buildings.

In order to protect the valuable records of the government from danger by fire, Congress has made an appropriation for the installation of a modern system of auxiliary fire protection for three of the largest buildings occupied by the Department of the Interior in Washington. A committee has been appointed to investigate the relative merits of systems adaptable to the buildings of the department and to prepare plans and specifications. All communications regarding the subject should be addressed to the Chief Clerk of the Interior Department, Washington, D. C.

A Modern Hotel Heating System.

The heating system of the Hotel McAlpin, recently erected in New York, represents the latest development in hotel heating. This building, which has accommodations for 2,500 guests and rises twenty-five stories above Broadway, cost $13,500,000, and in every way is representative of the best in construction and equipment.

The structure is heated by two distinct Webster vacuum systems, one of which is a low-pressure downfeed vacuum system, with the supply main located on the twenty-third floor. The first three floors are heated on an upfeed system and are fed from a separate main in the basement. The grill room, main dining room, halls, corridors, etc., and nearly everything below the first

RADIATOR IN HOTEL McALPIN ENCLOSED IN WINDOW CASING. SHOWING MODULATION VALVE WITH EXTENSION STEM.

floor, are heated by indirect radiation, the equipment including five air washers.

There is 53,000 sq. ft. of direct radiation in this building, the number of direct radiators being 2,150. Each is fitted on the return end with a Webster syphon thermotor which permits water and air to pass through, while tight against any steam leakage. At the supply end of 800 of the radiators are Webster modulation valves by which just the amount of heat necessary for a comfortable room temperature can be obtained by operating a dial on top. These modulation valves have extension stems and the radiators are enclosed in window cases which are provided with plain lattice grills that match the woodwork.

The distribution of steam for various heating purposes takes place at a muffler tank located in the engine room. This tank is provided with the necessary flanged outlets for supplying the direct radiation, the tempering and heating coils of the indirect system and the hot water heaters.

The main exhaust is 18 in. in diameter, the branch taken off for the upfeed system for the first three floors being 1 in. in diameter, while that taken off at the 23d floor is 14 in. in diameter. The back pressure valve on this 18-in. distributing riser is located on the 25th floor. The returns of both of the upfeed aand downfeed systems are connected to two vacuum pumps located in the basement. The drips of both systems are hooked together and connected to the 2,000 H.P. Webster feed water heater, purifier and filter. This is located in the basement. The condensation from the blower coils is taken care of by about 70 Webster water seal motors.

The discharges from the two vacuum pumps are carried to an air separating tank which is vented to the atmosphere, the condensation being delivered to the feedwater heater mentioned, through a loop seal.

The main dining room is heated by a direct-indirect system of special design and arrangement. There are 12 radiators in two tiers of three sections each, located in enclosures under the windows with intake connections to same extending from the outside through the wall and from the room through a grill of special design in the radiator enclosure. A steam supply to these direct-indirect radiators is controlled automatically in each case by means of a Johnson thermostat and a diaphragm valve; while the dampers are controlled pneumatically by means of push button switches and diaphragm damper attachments, and connected to the Johnson system in such a way that the operation of the push button switch by hand so controls the damper arrangement under the radiator that air is admitted to the radiator from the outside and shut off from the room or vice versa. The heated air rises from the radiator in each case and comes into the room through a grille located at the top of the radiator.

The hotel was designed by F. M. Andrews & Co., architects, New York, while the Thompson-Starrett Co. were the heating contractors.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Supplementary Report of Annual Convention.

At a meeting of the council of the society, held during the summer meeting at Buffalo, it was decided to appoint committees to review the reports rendered by all committees during the history of the society having to do with standards in the field of heating and ventilation. These committees are to be appointed in the immediate future, and they will be asked to review all these reports and suggest improvements and embody the result of their work in a report to be given at the next annual meeting of the society. Some of the reports which will be revised have to do with boiler ratings, radiator tests, tests of vacuum systems, standards of legislation for motion picture show places, standard pipe sizes for heating work and the like.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Supplementary Report of Annual Convention.

In addition to the proceedings of the National Association of Master Steam and Hot Water Fitters, as given out at the recent annual convention at Niagara Falls, a number of matters were discussed in executive session which are now available through their publication in the association's *Official Bulletin.*

For instance, the Committee on Standardization reported that it had made considerable progress in the matter of standardizing the diameter, drilling and thickness of flanges for standard weight pipe from 32-in. to 100-in. diameter inclusive, and also standardizing the diameter, drilling and thickness of extra heavy flanges, 26-in. to 48-in. diameter. These projects have proceeded to a point where the master steam fitters' association and the American Society of Mechanical Engineers are agreed on a schedule and further word is now awaited from the standardization committee of the American Water Works Association before a final report is drawn up.

STANDARD KEY FOR AIR VALVES RECOMMENDED.

The Standardization Committee also recommended the adoption of a standard key for air valves to be known as the "National Association Standard Key," to be applicable not only to the key air valves, commonly used on hot water radiators, but to all automatic air valves which are adjusted with a key. Makers of all such valves will be asked to make their valves to fit this standard key. The port of the key is to be made to take a 3-16-in. square nut; the depth of the port to be ¼-in., and the outside diameter of that part of the key fitting into the shield to be 7-16-in.

Some progress has also been made in the standardization of radiator valves, lists being compiled so as to compare the different dimensions of some of the principal makes. At the present time, the committee reported, it seems to be the consensus of opinion that not all the parts of a radiator valve should be standardized, but only those parts which will make them interchangeable, such as the center to end of the inlet and outlet and the dimensions of the plates which go on either side of the hand wheel and the method of fastening the hand wheel to the spindle and, possibly, the threading of the stuffing box. It was felt that the diameters of the hand wheels and the heights of different valves might vary, so long as the center to end dimensions are alike in all valves.

PROPOSED RATINGS FOR HOUSE HEATING BOILERS.

On the subject of boiler ratings, the committee stated that all sorts of schemes have been considered, the principal one being a rule based on grate surface as compared to fire surface and the relative value of fire surface in the different makes of boilers. The committee believe such a rule is impracticable and in its report suggested that the boiler maker should rate his own boiler, basing the rating on certain standard conditions. Accordingly, the committee proposed that the manufacturers be asked to publish a rating for their various sizes of boilers, to be known as the "National Association Rating," to be based on the following conditions.

1. That it shall not be necessary to fire the boiler more often than once in 8 hrs. to carry its rated load continually.

2. That coal used shall contain not less than 12,000 B. T. U. per pound of coal as fired.

3. That boiler ratings shall be based on a condensation of 0.3 lb. of steam per hour per square foot of direct cast-iron surface.

4. That the area of the vertical smoke flue and its height shall be great enough to provide a sufficient draft. The committee adds that it does not care how many other ratings the manufacturers may publish so long as they print the "National Association Ratings," based on the above conditions. The committee was composed

of William T. English, chairman; Earnest T. Child, N. Loring Danforth, T. B. Cryer, William H. Oakes and Edward B. Denny.

At a later session the convention formally adopted resolutions favoring the recommendations proposed by the Committee on Standards with respect to air valve keys and boiler ratings.

An interesting recommendation made by the Committee on Ways and Means and Good of the Order was that the association's motto, "Who Helps Me I Help," be changed and that a new motto be selected by the association. No action was taken on this proposal.

The convention revised the association's constitution, including the trade resolutions. The general policy of trade protection is adhered to, the resolutions defining "trade protection" as meaning that "manufacturers of, and wholesale dealers in, materials which enter into the construction of heating and ventilating systems, steam power plants and other pipe work done by members of this association, shall sell only to those who are regularly established in our line of business, and shall leave the preparation of plans and specifications to the engineer and heating contractor."

National District Heating Association.

In accordance with a resolution passed at the annual meeting of the National District Heating Association, Secretary D. L. Gaskill has sent to all central station heating plants in the country, including those in Canada, copies of the papers on "Commission Control of Public Utilities," by Secretary Gaskill, and on "Appraisal of Heating Properties," by Harold Almert, both of which were presented at the recent annual meeting.

Announcement is also made that the edition of the 1912 Proceedings, which was destroyed in the Dayton flood, is being reprinted with the funds pledged for that purpose by members at the Indianapolis meeting, and will be sent out by September of this year. The proceedings for 1913 will be mailed at the same time.

The association's constitution, as amended at the last annual meeting, has been printed for distribution among members, as well as a revised membership list, brought up to June 1, 1913.

How Good Air Helps.

Frequently in industry it is the little things that count strongly in the joint favor of workers and their employers. In an Indiana factory, where for years trouble had been experienced each summer by reason of absences due to minor illnesses, the manager concluded that the water, which was far from good, was partly if not wholly to blame. Last summer he supplied his men with lemonade to drink, adding ginger because that substance is cooling to the blood. "The good results were almost immediately apparent in a steadier attendance," says Factory in a recent issue.

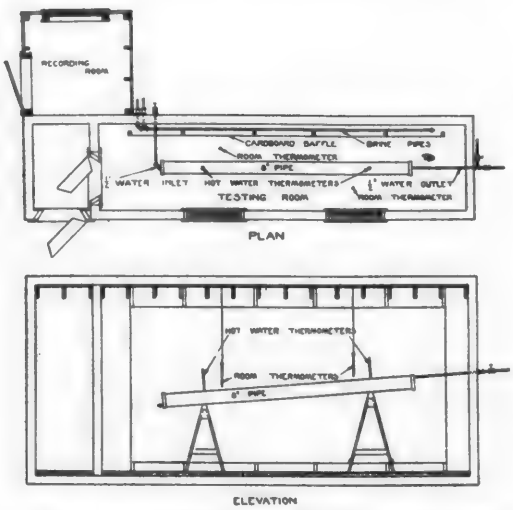
"But," that publication adds, "the cases of minor ailments and percentage of accidents still remained entirely too high, in the opinion of the manager, so he investigated further. He went around in different portions of the plant and himself tested the ventilating conditions. They were far from satisfactory. So he enlisted the services of a ventilating expert, who made an exhaustive investigation and report, as a result of which a complete system of mechanical ventilation was installed. The effect of this change was speedily apparent in the reduction of the percentage of absences to a reasonable figure."

The Beaver Falls Heat Transmission Testing Station.

The notable results obtained at the heat transmission testing station, conducted by the Armstrong Cork Company, at Beaver Falls, Pa., lend interest to the detailed description of the arrangements at the station which were described by H. W. Prentis, Jr., manager of the company's publicity department at the Indianapolis convention of the National District Heating Association.

The station was established six or seven years ago, at Beaver Falls, Pa., with competent engineers in charge. A mass of data has thus been obtained relative to the heat conductivity, not only of insulating mediums of all kinds, but of building materials —stone, concrete, and brick, as well.

This comprises a well-insulated room, approximately 25 ft. long, 6 ft. wide and 8 ft. high, and a three-ton refrigerating machine. The testing apparatus proper consists of 15 ft. of 8-in. pipe, blanked off at each end with a cap and set up on wood supports inside the testing room. There is a ½-in. inlet at the bottom of the pipe at one end and an outlet of the same size at the top of the pipe at the other end, through which hot water flows by gravity. One of the supports is higher than the other, so that the pipe slopes upward, preventing air pockets from forming. When covering is being tested, the entire 15 ft. of 8-in. pipe is covered with the material under test. In testing the loss from bare



ARRANGEMENT OF PIPE COVERING TESTING ROOM.

pipe, the pipe, needless to say, remains uncovered.

Two calibrated thermometers are set in the pipe 10 ft. apart—2½ ft. from each end —so that the bulb of each thermometer comes about at the centre of the pipe. The thermometers are set at that distance from the ends of the pipe in order that it may be carried on supports outside of the portion under test, namely, the 10 ft. between the two thermometers. The temperature of the room, which is cooled by brine pipes hung along one side, is indicated by two Fahrenheit thermometers, one on either side of, and hanging about on a line with, the 8-in. pipe. A baffle plate, extending from 6 ins. above the floor to within 6 ins. of the ceiling, is placed in front of the coil to prevent direct radiation and to assure circulation and uniform temperature throughout.

Method of Making Tests.

The procedure in making tests is as follows: The refrigerating machinery is started, and hot water allowed to flow through the 8-in. pipe. After constant conditions are obtained, the hot water is continually circulated through the pipe and the room held at whatever temperature is decided on for 24 or 48 hours additional, before readings are taken. During the whole of each test, the temperature of the testing room is held constant and the temperature of the ingoing hot water, and the amount of flow kept as nearly uniform as possible. The two hot water thermometers and the two room thermometers are read every 15 mins. through windows in the test room, and the hot water flowing through the pipe is caught and weighed with great care. The hot water outlet thermometer, of course, gives a lower reading than the in-

INSULATED ROOM IN WHICH PIPE COVERING TESTS ARE MADE.

let thermometer, this difference being due to the heat which is lost by the hot water in passing through the test area, namely, the 10 ft. of pipe between the two thermometers. All the water is brought in contact with the bulbs of both instruments by means of an ingenious series of baffles in the pipe.

At the expiration of each test the average difference in temperature between the inlet and outlet thermometers in the pipe, and the average difference in temperature between the hot water and the air in the testing room are determined, and the number of pounds of hot water flowing in 24 hours ascertained. If bare pipe is being tested, the surface area of the 10 ft. between the two thermometers must be determined; if covering, the area at the mean circumference.

A VIEW INSIDE THE PIPE COVERING TESTING ROOM.

From these data the total loss of heat is computed by the following formula:

STEAM PIPE COVERING TEST FORMULA.

The heat loss in British Thermal Units, per sq. ft., per degree difference in temperature for 24 hours $= \frac{A \times B \times C}{D \times E}$ where

A is the number of degrees loss in temperature of the hot water in passing from one thermometer to the other in the pipe;

B is the number of pounds of hot water flowing through the pipe in 24 hours;

C is the specific heat of the hot water, or, in other words, the quantity or heat required to raise one pound of water 1° F, which is one British thermal unit;

D is the number of degrees average difference in temperature between the air outside and the water inside, and

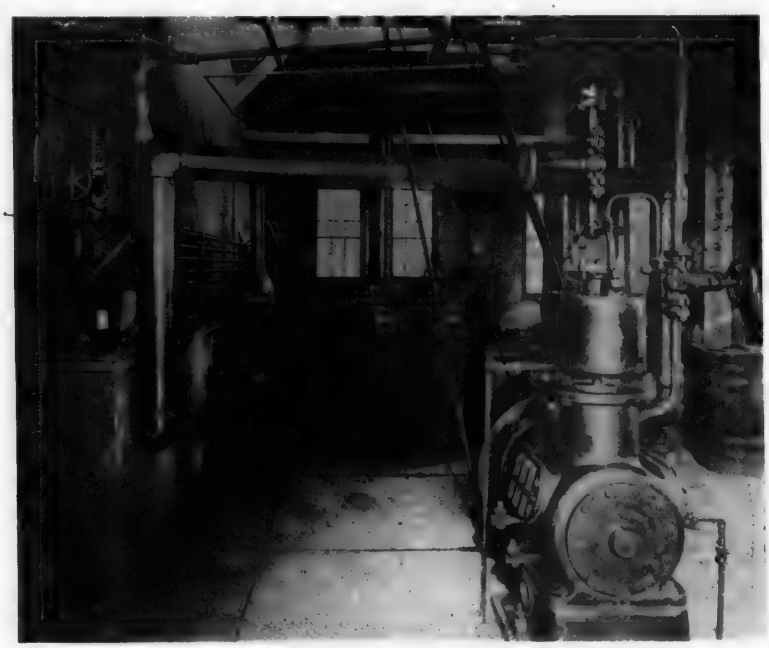
E is the area in square feet at the mean circumference of the 10 ft. of covering between the two thermometers, or the surface area of the 10 ft. of bare pipe, whichever is under test.

Since the heat transmission through any insulating material of uniform structure is in inverse proportion to its thickness, the results may be readily reduced to the standard basis, namely per square foot, at the mean circumference, per one inch thickness, per degree difference in temperature for 24 hours. This is accomplished merely by multiplying the transmission through the covering per square foot at the mean circumference, by the thickness

of the covering in inches. This unit transmission, once determined for any form of covering, the transmission through covering of the same description of any thickness can be readily calculated. Moreover, by this means the relative efficiency of two different coverings of different thickness can be compared on a common basis.

HEAT LOSS FROM BARE PIPES.

The results obtained indicate that the average loss from bare pipe of different sizes is approximately 51.9 B. T. U. per square foot of pipe surface per degree difference in temperature for 24 hours. The transmission through diatomaceous earth covering has been found to be approximately 7.9 B. T. U. per square foot at the mean circumference per one inch thickness per degree difference in temperature for 24 hours. Using these figures as a basis, let us take a concrete case and see exactly what thickness of covering should be used if a line is to be properly insulated from the standpoint of economy in operation.



REFRIGERATING MACHINERY OF THE HEAT TRANSMISSION TESTING PLANT.

EXAMPLES SHOWING EFFECT OF COVERING PIPES.

Let us assume that we have 1,000 ft. of 12-in. line carrying steam at 5 lbs. pressure. All of the piping is underground, encased in 18-in. split tile. The average temperature of the ground, during the heating season is, we will say, 55° F. Under these conditions we find that the condensation would amount to 0.387 lbs. of steam per square foot of pipe surface per hour. Now on 1,000 ft. of 12-in. line there are 3,300 sq. ft. of pipe surface. The total loss per hour would be 1,288.71 lbs. Figuring that it costs 30c. per 1,000 lbs. to generate and deliver steam, in a heating year of 5,832 hours—from Oct. 1 to June 1—this loss would amount to $2,254.73.

Applying 1½-in. covering made of diatomaceous earth, we find that the loss amounts to 0.246 B. T. U. per square foot of pipe surface per hour, which is equivalent to 0.044 lb. of steam per square foot per hour. With steam at 30c. per 1,000 lbs. and with a heating season of 5,832 hours, the entire heat loss from 1,000 lin. ft. of 12-in. steam line would be $256.35. In this calculation we have taken no account of the air space around the outside of the covering, which would, perhaps result in a further slight reduction in the loss.

Subtracting the amount of steam loss with the covering, viz., $256.35 from the loss with the bare pipe $2,254.73, we find that the net saving effected by 1½-in. covering would be $1,998.38. In other words, the 1½-in. covering saves 88 per cent. of the loss from the bare pipe.

Now let us substitute 2-in. diatomaceous earth covering for the 1½-in. on our 1,000 ft. of 12-in. line and ascertain whether the additional saving effected justifies the ex-

pense. It should be borne in mind that the adding of the extra half inch of insulation would not necessitate any increase in the size of the tile, owing to the allowance which must necessarily be made for the flanges. With 2-in. covering we find that the heat loss with 5 lbs. steam pressure and a ground temperature of 55° F. would amount to 0.19 B. T. U. per square foot of pipe surface per hour, which is equivalent to 0.034 lb. of steam per square foot per hour. In a heating year, therefore, of 5,832 hours with steam at 30 cents per 1,000 lbs., the loss with the 2-in. covering would be $198.08.

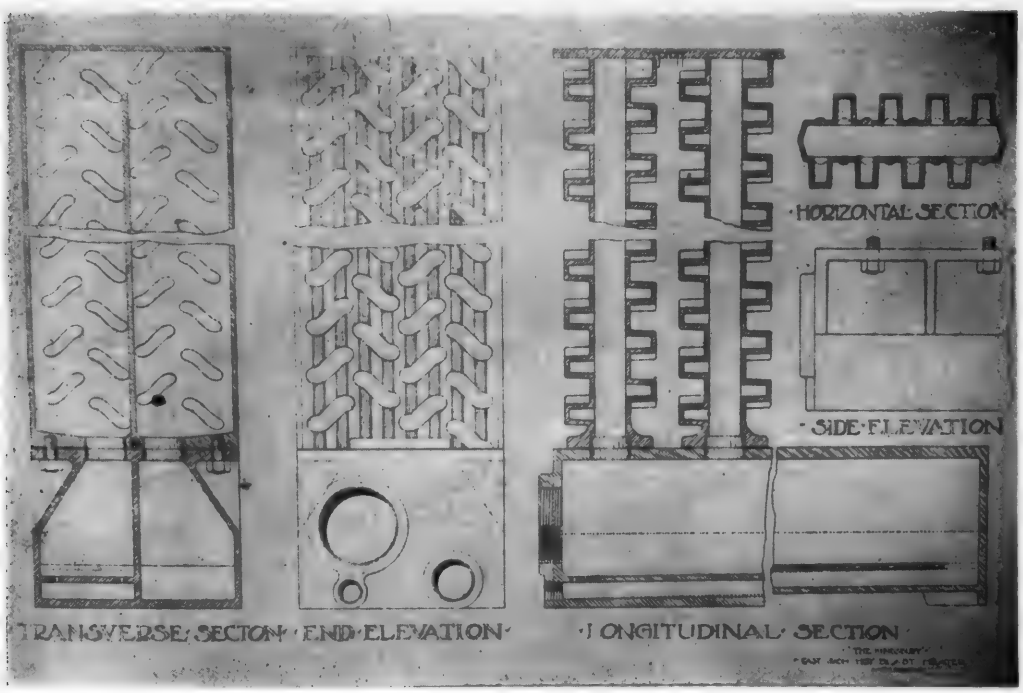
Now, the loss through the 1½-in. covering was $256.35, whereas through the 2-in. covering it is only $198.08, so the saving effected by the extra half-inch of insulation is $58.27 per annum. Allowing 10 per cent. for interest on the investment and depreciation, we would, therefore, be justified in paying $582.70 for the extra insulation—$58.27 being just 10 per cent. on that amount. Now the cost of 1½-in. covering applied would be approximately $1.11 per lineal foot; for the 2-in. covering, $1.62 per lineal foot, so that the extra cost would be 51 cents per lineal foot or $510 for the entire line of 1,000 ft. It is apparent, therefore, that the 2-in. insulation would be a good investment, as it would actually cost less than the amount we would be justified in paying for it. It would save 91 per cent. of the loss from the bare pipe, as compared with 88 per cent. for the covering 1½-in. thick.

In this illustration the speaker used diatomaceous earth covering as the basis for figuring since he could speak regarding its efficiency and its cost with authority, but of course, the same line of reasoning is equally applicable in the case of any other high grade covering of known efficiency.

New Fan Blast Heater.

Using a combination of the cast-iron base of the ordinary pipe blast coil and the cast-iron section of a sectional radiator, W. M. Kingsbury, heating and ventilating engineer for the Board of Education of Cleveland, Ohio, has recently perfected a unique and remarkable type of apparatus, known as the Kingsbury cast-iron blast heater. A patent is now pending on Mr. Kingsbury's invention.

The base of this new heater has a vertical lognitudinal partition which divides it into a supply side and a return side. In the old pipe blast coil of the corresponding construction, trouble was sometimes experienced when the base was made too long and the heating surface in the pipes too great for the cross section of the supply side, in that the high velocity of the steam, in entering the base, backed up the water in front of it, thus preventing the water from flowing back to the drip pocket



KINGSBURY CAST-IRON HOT BLAST HEATER.

provided, and resulting in a large part of the heating pipes being sealed off with the water.

This difficulty has been overcome in the Kingsbury heater by casting a horizontal partition the width of the supply side of the base near the bottom, the end farthest from the supply opening being cut off within an inch and a half of the end of the base. This provides a space for the water to fall over into the lower drip chamber and permits it to flow back to the drip opening below the supply connection, without coming in contact with the incoming steam.

The heater section is made with a vertical transverse partition corresponding with the partition in the base, which ends within a couple of inches of the top, leaving a means of communication between the two sides of the section near the top.

The steam enters from one side of the base, rising on the corresponding side of the section, and passes over the top of the partition, dropping down on the return side, compelling a complete circulation of the steam and a perfect venting of all the air on the inside of the heater.

The shape and arrangement of the projecting lugs was made the subject of considerable study, the idea being to secure outlines which would permit of perfect castings and at the same time get the effect of baffle plates.

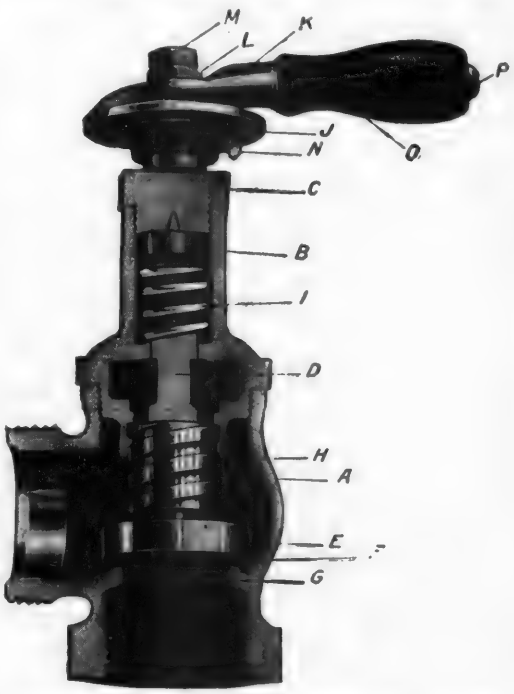
All the lugs are cored, thus giving a large amount of prime surface. Vertical corrugations on the plane part of the section give additional surface and stiffness.

The entire construction is such as to permit the use of high steam pressures.

The sections are connected to the base with the well-known push nipple construction and stud bolts. The top of each section is made with a flat flange so that when a number of them are assembled in a row, they form a natural platform on which to set another base, and make the heater two or more tiers high. The end elevation shows the various pipe connections, i. e., the supply, drip and return.

It is intended to make some extensive tests and as as soon as these are completed they will be compiled into tables for the use of engineers. One great advantage of this design is that one fitter and helper can assemble any size heater without block and tackle and be reasonably certain that the joints are tight.

INSIDE INFORMATION ON THE SYRACUSE PACKLESS RADIATOR VALVE, made by the Syracuse Faucet & Valve Co., Syracuse, N. Y., is the title of a circular containing not only a detailed description of its construction, but also showing views of the various types, including one sectional view disclosing the entire arrangement of the different parts. The Syracuse packless radiator valve is described as different from all others. For instance, when a force is exerted against the side of an ordinary valve, the stem may be injured in such a way as to bind and become hard to operate. This is avoided in the Syracuse valve as the stem is encased in such a way that no part of it is exposed. The wheel handles open and close in one complete turn. Valves can be



SECTIONAL VIEW OF SYRACUSE PACKLESS RADIATOR VALVE.

furnished with lever handles, if desired. One of the special features of construction is that there is a metal-to-metal joint between the top and the bonnet. Leaks at this point are said to be positively prevented, as the joint is proof against air, steam or water. Around the valve stem there is another leak-proof joint. No asbestos or other packing is necessary, as all possible points are seated and protected by the use of composition discs. The disc is held in place by a bronze non-corrosive spring. The tension at all times holds the composition disc against the upper seat. The disc holder, which holds the composition disc forming the lower seat in the valve, is spun on the disc carrier in such a way that it may revolve and allows the carrier to take its seat properly when closed.

Modern Vacuum Cleaning Apparatus

10—Connersville Vacuum Cleaners.

The United Vacuum Appliance Company, of Connersville, Ind., has for several years used the vacuum pumps manufactured by the Connersville Blower Company and for this reason its installations are known as the "Connersville System." The Connersville blowers and vacuum pumps are of the positive type, consisting of two rotating impellers inside a case and held in relative position with each other by outside gears, so that there is no actual contact one with the other, or with the case. They are so accurately machined, however, that the clearance is small, allowing very little slippage of air back through the machine.

Since there is no internal contact, the only loss of power is that caused by journal friction and the air slippage just referred to. The journals are of the ring-oiling type, keeping them well-oiled at all times; thus making this source of loss quite small. The speed of the blower is comparatively low, practically eliminating the loss caused from skin friction in the pump. There are no parts, or small passages through which the air must pass at high velocity with accompanying losses. As the vacuum pump is the heart of any vacuum cleaning system, it is advisable to investigate its efficiency and other features.

In competitive tests, the horse-power re-

FIG. 1.—CONNERSVILLE RESIDENTIAL VACUUM CLEANING UNIT.

quired by the Connersville System has shown such economy that the system is being imitated by some manufacturers of vacuum appliances for installations in which economy is a feature considered.

The readers of THE HEATING AND VENTILATING MAGAZINE, during the past few months, have been given a very comprehensive discussion of the various types of vacuum cleaning apparatus now on the market and a casual glance through these articles will readily show one the varying demands upon the cleaning apparatus. When the cleaning tool is on a hardwood floor for effective cleaning, a large volume of air at a low vacuum is required and when the tool is cleaning a heavy Brussels carpet, a much higher vacuum is necessary. When the room to be cleaned is in a private residence and is cleaned each day, the vacuum should be low and the tools light. For cleaning hall carpets of hotels, a much heavier design of apparatus is necessary, with a high vacuum. To meet these various conditions frequently entirely differently-constructed vacuum producers are used, but this is not so with the Connersville System. During the past year the United Vacuum Appliance Company has run a series of exhaustive tests to find the actual field of the Connersville System and has found that the economical range is from 2-in. (mercury) vacuum to 15-in. vacuum. This range covers all kinds of cleaning.

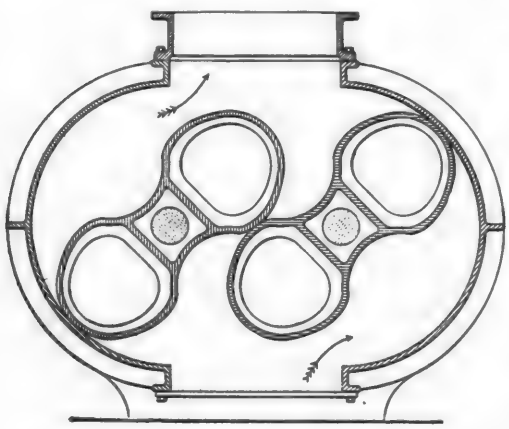


FIG. 2.—CROSS SECTION OF CONNERSVILLE PUMP.

On installations of more than two sweepers, some regulating device is necessary for economical operation of the plant when only a small per cent. of the total number of tools is being used. In steam-driven plants, a diaphragm vacuum regulator varies the speed of the engine, keeping the vacuum constant with the various number of cleaning tools in operation.

For electrical-driven units, a patent unloading valve of special design is used, allowing the use of a constant-speed motor. The operation of this valve is quite positive. As the pump starts up, the valve is in such a position that it allows a direct passage of air from the dust collector to the pump and remains in this position while all of the tools are in operation. As soon as one or more of the tools are shut off, the speed of the pump will cause the vacuum to go above the normal for which the valve is set and the valve will automatically change its position for a few seconds, disconnecting the pump from the dust collector and allowing it to run idle until the vacuum again drops below normal; at which time the valve again changes back to the original position.

With this valve, no noisy check valve is required, since the valve performs that function also. At times when the line is entirely closed, the pump runs idle a large portion of the time, the leakage through the valve being surprisingly small, due to its special patented construction. The lack of electrical troubles and the reliability of this valve has made it popular for motor and gas-engine driven units. With it installed, the power consumption is nearly in proportion to the work being done by the tools.

For installations where the control is entirely electric, outfits are furnished with a specially-designed controlling switchboard and a variable speed motor and, when so ordered, remote control is furnished. Its operation is as follows: The person desiring to sweep an upstairs room pushes a button which starts the motor bringing it gradually to its maximum speed until the desired vacuum is obtained and then the controller automatically changes the motor speed, keeping the vacuum at the predetermined amount and varying to suit the number of tools being used. On all pumps a safety valve is installed to prevent undue strain on the pump and motor should the controller fail to respond promptly to any quick change in the service.

Motor-driven outfits are of three classes, namely, belt-driven, silent chain-driven, and direct-connected. The least expensive is the belt drive, which permits the use of a high-speed motor and a stock pump. Next in cost is the chain-driven, but for compactness and efficiency the direct-connected units stand prominent.

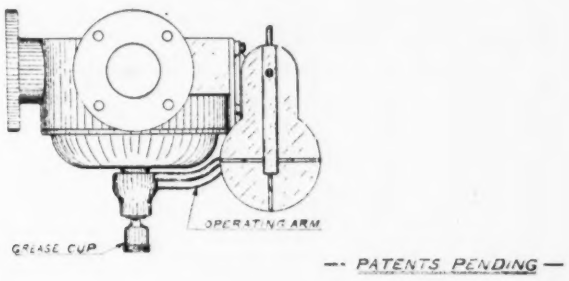
Dust collectors are supplied to suit the purchaser's wishes on large units, but for

units up to four sweepers, a tank, equipped with a bucket forming the lower portion, is meeting with favor. The bucket is so constructed that it makes an air-tight joint at the bottom of the tank and at the same time is quickly and easily disconnected and the dirt carried out and emptied. Tanks which must be emptied with a shovel cause a very unpleasant and unhealthy task for the person assigned to this work.

The foregoing has reference to dry separation, but for wet separation, the Connersville patent self-flushing automatic units eliminate the labor of emptying the tanks. With the automatic tank, the starting of the pump draws into the tank a definite quantity of water, regulated by a patent water valve designed for this service. The air charged with dust and dirt is cleaned by passing through this water. When the day's work is over, the pump is stopped, the vacuum drops and the tank automatically empties itself of the muddy water, passing it off to the sewer. When the pump is again started, a fresh supply of water is drawn into the tank and the operation repeated.

The size of hose for various purposes cannot well be kept the same. For low-vacuum cleaning, as is the case in school house cleaning, a larger hose should be used than would be required for high-vacuum work, as with rugs and carpets. Much power can be lost by having the piping and hose too small, while an excessively large hose can hinder the process of cleaning, making the labor cost more. So the selection of the pipe size and hose size should be left to the company who has experimented with their type of apparatus, knowing what sizes have proved to be the best for the service contemplated.

The question often comes up as to the comparative value of portable vacuum cleaners and the central vacuum cleaning system. However, experience has amply proved that, in practically all cases, the slight extra cost for the central system is more than compensated for by its many advantages. With the central system, the foul air containing dust and germs is sucked up through the carpet or tapestry and conveyed to a receptacle in the basement where the dust is deposited and the air itself discharged out doors by the vacuum pump, instead of being discharged back into the room, as occurs with the portable units. The noise of the machinery, too, is kept in the basement. In some classes of vacuum cleaning, however, portable units are required and to meet these demands a small truck outfit is manufactured by the United Vacuum Appliance Company, which is of ample size to do ef-



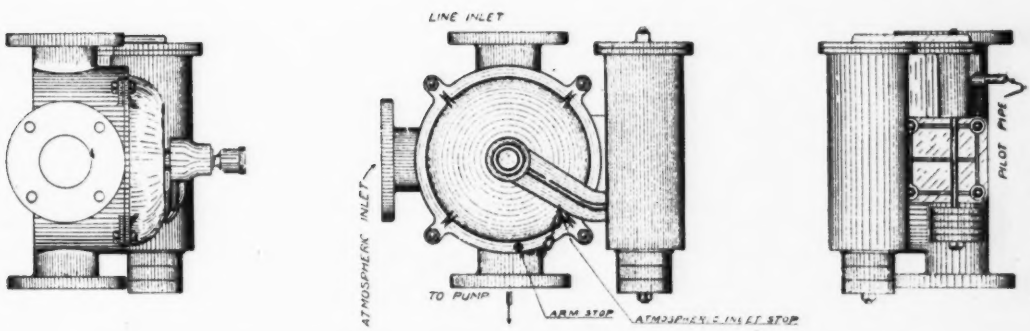


FIG. 3.—THE HOUGHTON UNLOADING VALVE.

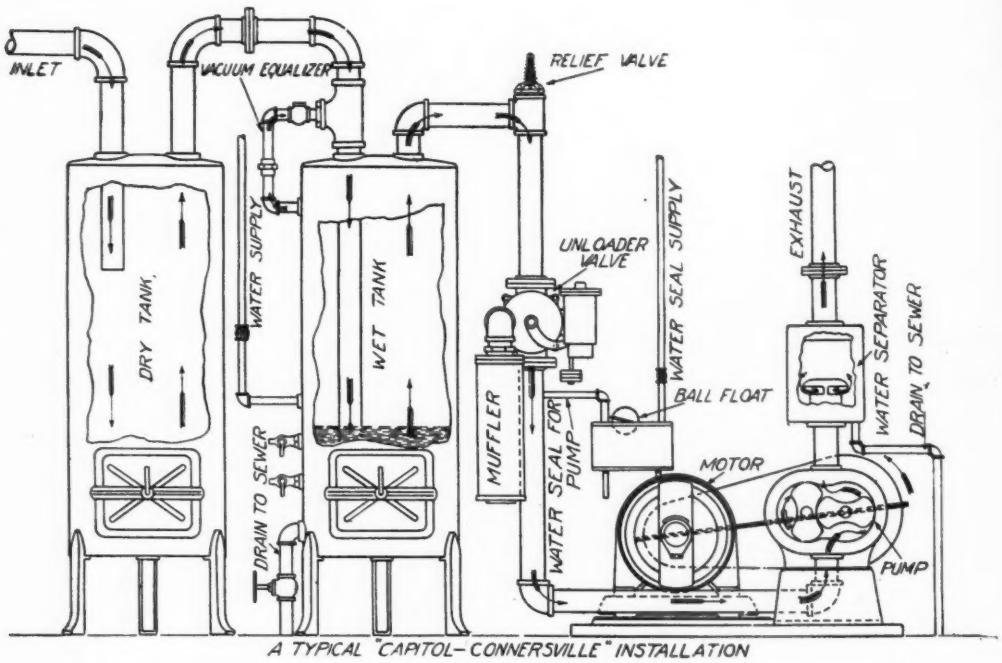


FIG. 4.—CROSS SECTION OF SIX-SWEEPER CONNERSVILLE SYSTEM.

fective cleaning, both for high and low-vacuum service.

One feature of great convenience and in many cases a necessity obtainable by the Connersville System is the fact that by closing a valve or two, the vacuum line can be connected to the pressure side of the pump and pressure used for cleaning out places which cannot be reached by the vacuum tool.

New $23,000,000 Heating and Lighting Company.

The Louisville Gas & Electric Company has begun its career, taking over the Kentucky Electric Company, the Louisville Heating Company and its subsidiaries, the Kentucky Heating Company, Kentucky Coke Company, Kentucky Fuel Gas Company, the George H. Foster Lighting and Heating Company, and the Campbell Electric Company. With a capital of $23,000,000 it will outsize any other individual public lighting and heating utility in the state.

Henry M. Byllesby, of Chicago, as chairman of the board of directors, will be the head of the new concern. Next in rank will be Gen. B. H. Harries, president. John J. O'Brien, Chicago, will be vice-president and general manager, and James D. Brown, of the National Bank of Commerce, Louisville, vice-president. The board of directors will be composed of the officers mentioned and the following: Charles J. Doherty, Dr. H. D. Rodman, Judge Matt O'Doherty, R. M. Trimble, of Mount Sterling; Daniel E. Doherty, Henry Osthoff, Chicago; Arthur E. Huey, Chicago; Col. John H. Whallen, John W. Barr, Jr., and Harry W. Fuller.

The acquisition of the Kentucky Electric Company will leave the way open for the posting of a $250,000 bond to guarantee the piping of natural gas from the West Virginia fields. For this purpose, the Kentucky Pipe Line Company, with a capital of $3,000,000, has recently been incorporated.

Articles on "Trade Journalism" by Elbert Hubbard.

We take pleasure in announcing that we have arranged for the publication, commencing with the September, 1913, issue, of twelve of the most interesting and instructive articles ever written on "Trade Journalism" from the pen of Elbert Hubbard. Mr. Hubbard will prove by example, show by experience and illustrate by logic, what has been gained and what is to be gained by reading and reflecting on the good things found in every issue of THE HEATING AND VENTILATING MAGAZINE. Of the many journals devoted to heating or

plumbing, The Heating and Ventilating Magazine is the only one in which these articles will appear.

Elbert Hubbard's writings are always entertaining and in the forthcoming series he will have many interesting things to say to reader and advertiser alike.

Trade Literature.

THERMOGRADE SYSTEM OF HEAT MODULATION is explained in an interesting manner in an attractive booklet, recently issued by The Consolidated Engineering Co., Chicago. The booklet sets forth the simplicity and economy of this system which permits of the absolute control of the heat in the radiator by means of a control valve, by which any part of the radiator may be heated. A number of illustrations are included of large buildings in which this system is installed, together with sectional views of the valves used in connection with the system. The Thermograde system, the company states, is also particularly adaptable to high-class residences and apartment buildings, churches, schools, theatres and clubs. It is claimed by the manufacturers that savings of as high as 40 per cent. have been effected by its use.

SPRAGUE MOTOR-DRIVEN EXHAUST FAN OUTFITS, direct and alternating current, giving, in concise form, all the necessary data for the use of engineers, contractors and buyers generally, are the subject of a newly-issued bulletin (Bulletin 246), published by the Sprague Electric Works, New York. The necessary characteristics needed to make up a successful fan motor outfit, the bulletin states, are admirably met by the round type direct-current, the riveted frame alternating current and the fractional horse power drawn-shell motors, all of which are thoroughly described in the bulletin. These characteristics, as stated in the bulletin, are that motors for disk and propeller fans must be compact, light in weight, and possess ample overload capacity. Any obstruction to the flow of air or counterdraft may so overload the fan that the motor, unless liberally and substantially designed, will burn out. The material and workmanship of the driving motors must be of the highest order, and the working parts, especially the commutators of the direct-current motors, thoroughly protected, as the outfits are required to run for long periods without skilled attention. The fans must be well balanced, practically noiseless and capable of delivering the maximum volume of air with the minimum expenditure of power. Size 7x10 in. Pp. 12 (punched for binding).

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